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A FAUNAL STUDY OF THE FREMONT FORMATION IN THE CAÑON CITY EMBAYMENT, COLORADO

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WILFRED JEARLE MONK

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A FAUNAL STUDY OF THE FREMONT FORMATION IN THE CAÑON CITY EMBAYMENT, COLORADO

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A FAUNAL STUDY OF THE FREMONT FORMATION IN

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CHAPTER I

INTRODUCTION

Location and Description of the Area

The area under investigation is located in southeastern Colorado in portions of Townships 16 South, Range 68 West, 17 South, Range 69 West, 18 South, Range 70 West, 19 South, Range 71 West, all in Fremont County, and Township 22 South, Range 69 West, Custer County.

The Cañon City embayment is a structural and physiographic basin which opens to the east. It is bounded on the north by the Front Range, on the northeast by the Denver Basin, on the east by the Las Animas arch, on the southeast and south by the Apishapa uplift, and on the southwest and west by the Wet Mountains. The Fremont formation forms one of the hogbacks along the margins of the Front Range, trending in a north-south direction on the eastern flank of the Rocky Mountain system. In the Cañon City embayment, the formations of the Front Range extend south from Colorado Springs, then sweep to the west, north of Cañon City, then southeastward

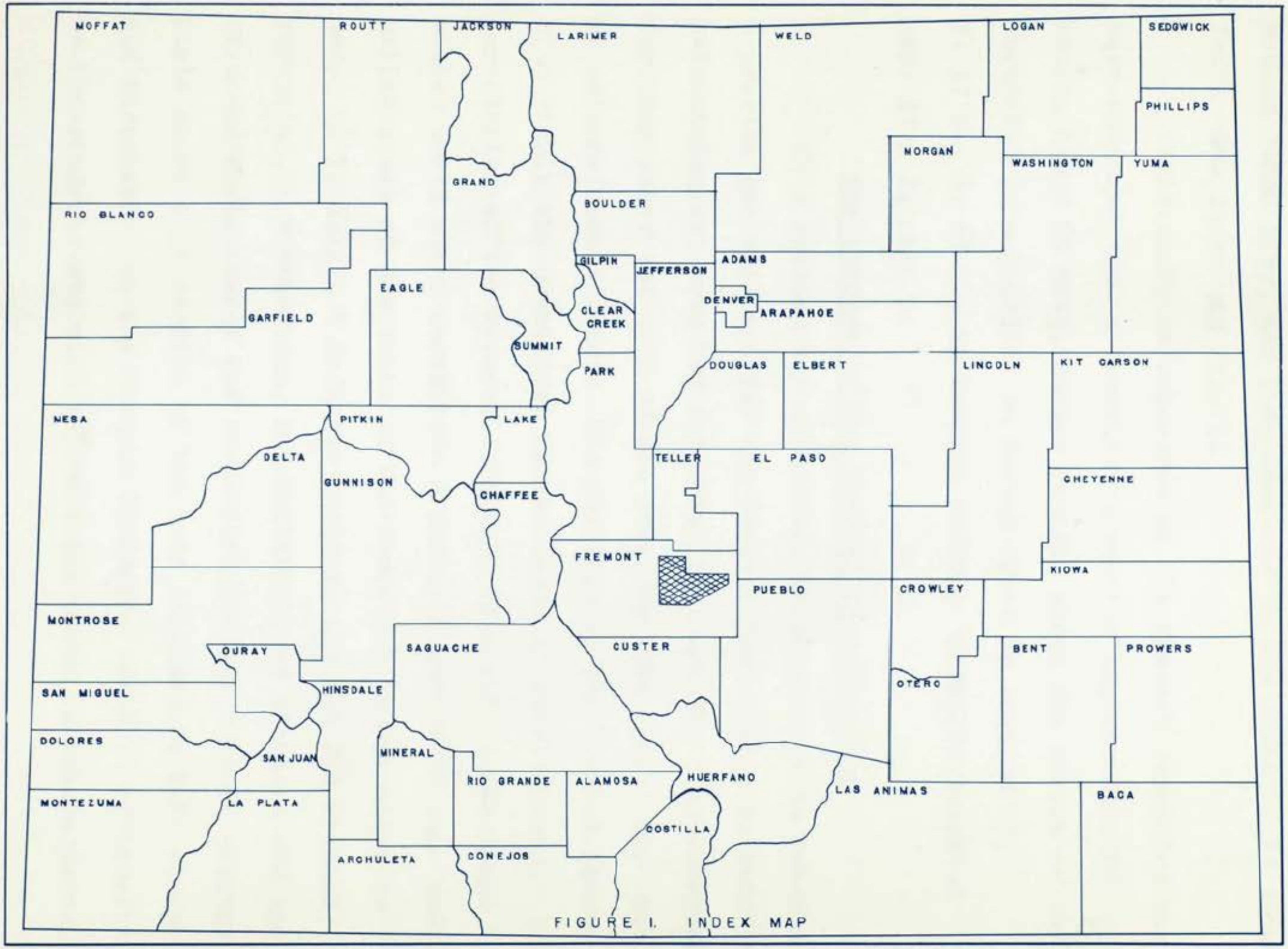

FIGURE I. INDEX MAP

W. J. MONK
M.S. 195?

around Cañon City, and then eastward to the meridian of Pikes Peak. See index map fig. 1.

This study on exposures of the Fremont formation has been extended from a locality in section 11, Township 22 South, Range 69 West, Custer County, along the strike of the formation to a locality on Beaver Creek in section 15, T. 17 S., R. 68 W., in Fremont County. Refer to location map; fig. 2, page 9.

The Purpose of the Present Investigation

This problem was undertaken in an attempt to establish a precise geologic age for the Fremont formation. No detailed paleontological work had been done in the Cañon City embayment for many years and much of the previous work was in the nature of reconnaissance study. The position of the Fremont formation within the Ordovician system was still undetermined. Correlation of the Fremont formation with well known Ordovician units would constitute a definite contribution. Detailed study of the fauna of the formation is necessary in order to establish a definite geologic age for the Fremont formation. Furthermore, the University of Oklahoma and the Oklahoma Agricultural and Mechanical College conduct geology field camps in a portion of the area included in this study and information on the Fremont formation would be of benefit to the students who will attend these camps in future years.

Methods of Investigation

The field work was done during the summer of 1953 from June until September. Faunal identifications and library research were completed in the laboratories and library of the University of Oklahoma, and photographs of the fossils were made in the geology department darkroom.

Stratigraphic sections were measured in the field by the use of the Brunton compass and a steel tape. The Brunton compass was also used to determine the dip and strike of the formation at the various sections which were measured.

The fauna was collected in the field from the different stratigraphic sections, and zones in which the fossils occurred were carefully noted. The Fremont formation is a resistant, dolomitic limestone throughout the whole area and the collection of fossils is extremely difficult. When a fossiliferous zone was located, the rock was broken up with hammers and those containing fossils were then boxed for shipment to Oklahoma. In the Specimen Hill section a portion of the section has been dynamited by amateur mineralogists who were collecting mineral specimens of the fine blue-white chert from this locality. This zone yielded many fossils.

Most of the fossils were removed from the rocks in the laboratory using a four-pound sledge and a hydraulic rock splitter. The silicified fossils were removed from the dolomitic matrix by the use of twenty percent hydrochloric acid.

Thin sections were made of the bryozoans and corals when possible.

Since the preservation of the fossils is poor, it was necessary to make casts of many of the molds for identification.

Two methods of making casts were used. In making casts by the first method one red piece and one white piece of Kerr Dental Wax were softened together in hot water and kneaded to give a pink color to the resultant mass. This mass was pressed into the mold while soft and allowed to harden. This is a quick and easy method of obtaining a cast and as an additional advantage the cast can be resoftened and the material used again.

A permanent cast was made from the molds by the use of a latex rubber compound. The latex was applied in a thin solution by a brush and allowed to harden. After two or more layers were applied in this fashion, undiluted latex was then put in on top of these layers to fill out the mold. Red food coloring was added to the latex to destroy the yellow-white color and make the cast pink so that it could be whitened to bring out the details for photographing.

Fossils were whitened by the use of ammonium chloride sublimate obtained by heating ammonium chloride crystals in a Pyrex glass tube and then blowing through the tube to direct the fumes onto the fossil. Magnesium oxide also was used in the whitening process by burning a thin magnesium ribbon underneath an inverted funnel on a ring stand. By this method a concentrated cloud of magnesium oxide could be directed onto the fossil.

A Leitz Aristophot camera with a 42 mm. Micro-Summar lens and a 120 mm. Summar lens was used to photograph the mega-fossils. The thin sections and the micro-fauna were photographed with the Aristophot camera in conjunction with the Leitz Ortholux microscope. Eastman Kodak Super Ortho-Press film was used. The photographs were then mounted on cardboard and re-photographed to obtain the plates.

History of Previous Investigations

The Fremont formation was first studied in 1892 by Charles D. Walcott.[1] He named the formation for Fremont County. Walcott described the type section at the Harding's sandstone quarry about one mile northwest of Cañon City, and gave a faunal list of the invertebrate forms that he found. This list contained thirty-four genera and fifty-five species of which Walcott identified twenty-six species. On the basis of this fauna Walcott established the Fremont as Ordovician and noted that the fauna indicated a Trenton age, but on the whole upper Trenton or Lorraine, rather than lower Trenton.

In 1933, a detailed study of pre-Pennsylvanian stratigraphy along the Front Range and in the Cañon City

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[1]Charles D. Walcott, "Preliminary Notes on the Discovery of a Vertebrate Fauna in Silurian (Ordovician) Strata," Bull. Geol. Soc. Amer., Vol. 3, 1892, pp. 153-172.

embayment was made by A. E. Brainerd, H. L. Baldwin, Jr., and I. A. Keyte.[2]

T. S. Lovering and J. Harlan Johnson,[3] discussed the unconformities present in the stratigraphy in central Colorado.

In 1945, J. Harlan Johnson,[4] in a resumé of the Paleozoic stratigraphy of Colorado, compiled all previous information on the Fremont, giving faunal lists, stratigraphic sections and an extensive bibliography.

John C. Maher, of the United States Geological Survey correlated the subsurface rocks of eastern Colorado and western Kansas with the rocks cropping out on the Front Range.

Walter C. Sweet,[6] made a study of the Harding and Fremont formations in Colorado. He divides the Fremont formation into two members, the massive dolomite member and

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[2] A. E. Brainerd, H. L. Baldwin, Jr., and I. A. Keyte, "The Pre-Pennsylvanian Stratigraphy of the Front Range in Colorado," Bull. Amer. Assoc. Petroleum Geologists, Vol. 17, No. 4, 1933, pp. 375-396.

[3] T. S. Lovering and J. Harlan Johnson, "Meaning of Unconformities in the Stratigraphy of Central Colorado," Bull. Amer. Assoc. Petroleum Geologists, Vol. 17, No. 4, pp. 353-374.

[4] J. Harlan Johnson, "A Resumé of the Paleozoic Stratigraphy of Colorado," Quart. Colorado School of Mines, Vol. 40, No. 3, 1945, pp. 24-30.

[5] John C. Maher, "Pre-Pennsylvanian Rocks along the Front Range of Colorado," U. S. Geol. Survey Preliminary Chart 39, Oil and Gas Investigation Series, 1950.

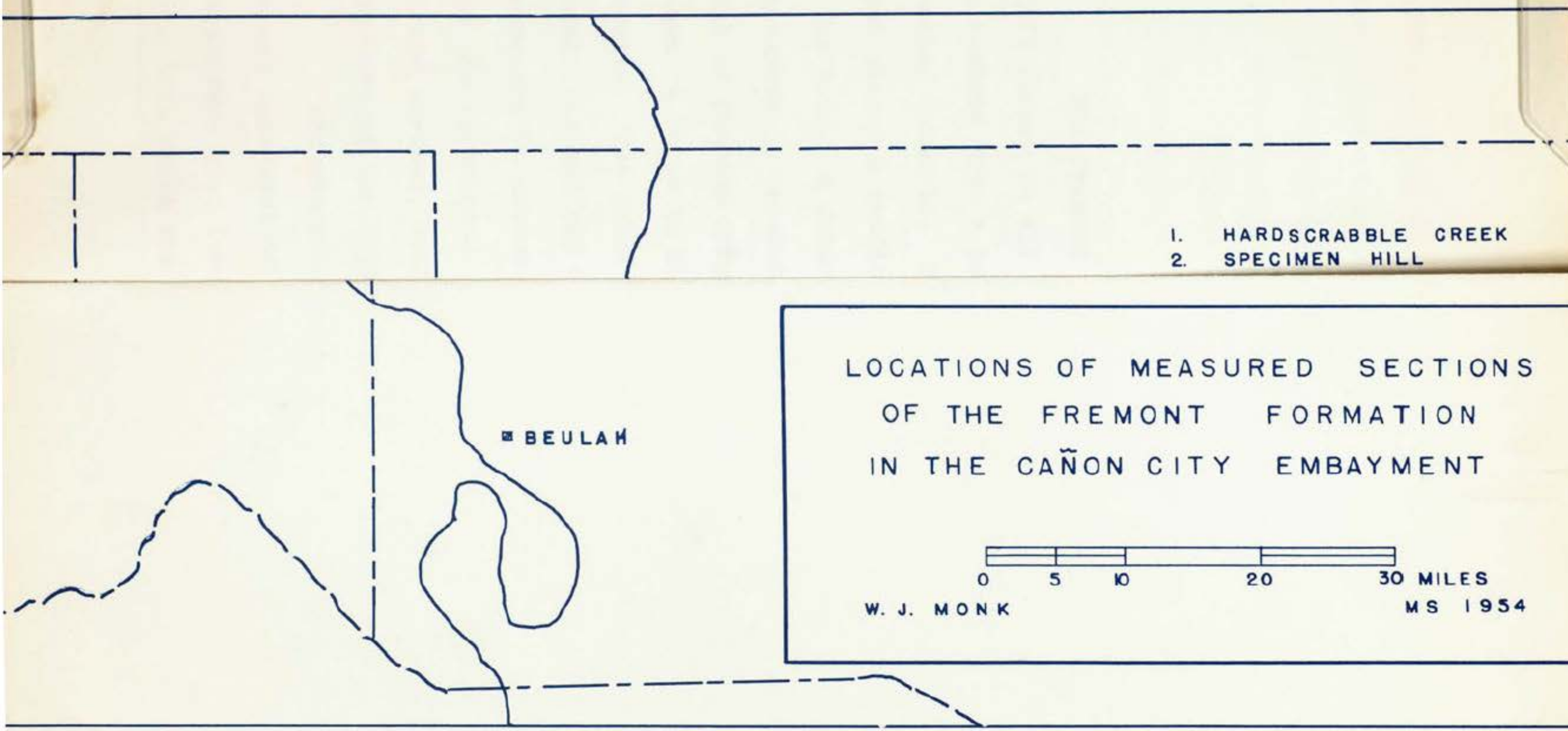
John C. Maher, "Detailed Sections of Pre-Pennsylvanian Rocks along the Front Range of Colorado," U. S. G. S. Circ. 68, 1950.

[6] Walter C. Sweet, "Harding and Fremont Formations, Colorado," Bull. Amer. Assoc. Petroleum Geologists, Vol. 38, No. 2, 1954, pp. 284-305.

the Priest Canyon member. Sweet also gives a faunal list for each of the two members.

In 1954, The Subcommittee on Ordovician Stratigraphy of the National Research Council,[7] published a correlation chart and annotations on the formations of the Ordovician system in North America. The Fremont formation is shown on the chart and is discussed by W. H. Twenhofel, a member of the committee.

[7] W. H. Twenhofel, et al., "Ordovician of North America," Bull. of The Geological Society of America, Vol. 65, No. 3, 1954, pp. 247-298.


1. HARDSCRABBLE CREEK
2. SPECIMEN HILL
BEULAH
LOCATIONS OF MEASURED SECTIONS
OF THE FREMONT FORMATION
IN THE CAÑON CITY EMBAYMENT
0 5 10 20 30 MILES
W. J. MONK
MS 1954

CHAPTER II

STRATIGRAPHY

The Fremont formation is massive bedded and is a cliff former in all sections where it is exposed. It varies in texture from a coarsely granular dolomite to a very fine-grained dolomite. The basal portion of the formation is at most places a reddish color while the upper part is tan to light buff. A dolomitic shale of five to eight feet in thickness is present near the top in some sections and northeast of Phantom Canyon parts of the formation are quite sandy. Chert is found in the formation along bedding planes and as nodules. The color of the chert is blue-white in some localities and tan to dark red in others, and is considered secondary in nature. Manganese dendrites are abundant throughout the formation. The formation weathers into a very rough, pitted surface, aptly termed "tear-pants" weathering by the students of the Oklahoma Geology Field Camp.

Maximum thickness of the Fremont in the embayment occurs northwest of the Colonna Bros. travertine quarry on South Twin Mt., (sec. 1, T. 18 S., R. 71 W., Fremont County). From this point the formation decreases in thickness to the north and south and is completely missing in some areas. This change in thickness is probably due to pre-Pennsylvanian erosion, except the area northeast of Phantom Canyon which appears to be the result of onlap relationships.

Underlying the Fremont throughout the embayment is the Ordovician Harding formation. The contact between the formations is irregular in the sections south and west of Phantom Canyon. Northeast of Phantom Canyon the contact appears to be conformable.

Brainerd _et al._,[8] reported a distinct erosional unconformity between the Harding and the Fremont along Oil Creek north of Cañon City, and also west of Beulah in Custer County. Johnson,[9] shows that along Deadman Creek in Gunnison County the Fremont formation rests directly on the Manitou dolomite of lower Ordovician age. Sweet[10] reports this same situation on Mount Tilton, also in Gunnison County. He also shows that 12-14 feet of unquestioned Harding sandstone intervenes between these formations in sections a short distance to the southwest and he concludes that its absence in the Mount Tilton and Deadman Creek sections is due to pre-Fremont erosion rather than to non-deposition.

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[8] A. E. Brainerd, _et al._, _op. cit._, p. 386.

[9] J. Harlan Johnson, "Paleozoic Stratigraphy of the Sawatch Range, Colorado," _Bull. Geol. Soc. America_, Vol. 55, pp. 303-378.

[10] Walter C. Sweet, _op. cit._, p. 297.

In Priest Canyon the Fremont rests on the yellowish-green shale of the upper Harding and this contact is quite irregular. Although Walcott,[11] in his original description of the Harding and Fremont formations places this shale member in the Fremont, Pollack,[12] indicates that the shale is lithologically similar to other shales in the Harding and that there is no reason for placing it with the thick carbonate rocks which comprise the Fremont formation.

Twenhofel et al.,[13] in the text accompanying the correlation chart of the Ordovician formations of North America states that:

> The Harding sandstone of Colorado is overlain by the Fremont limestone, apparently without stratigraphic break, and it is unconformable upon the underlying Manitou limestone (Walcott, 1892). Kirk (1930) assigned the Harding sandstone to the Trenton, but, unless it can be shown that a stratigraphic break lies above it, Twenhofel is of the opinion that it is best allied with the overlying Fremont limestone and considered the initial deposit of that formation.

In reference to the above, Pollack[14] has shown that the fauna of the Harding sandstone is mainly a molluscan fauna in conjunction with a large conodont assemblage. On

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[11] Charles D. Walcott, op. cit., p. 156.

[12] Jerome M. Pollack, "A Faunal Study of the Harding Sandstone in the Cañon City Embayment, Colorado," Unpublished Master of Science Thesis, University of Oklahoma, 1951, p. 11.

[13] W. H. Twenhofel, et al., "Correlation of the Ordovician Formations of North America," Bull. Geol. Soc. Amer., Vol. 65, No. 3, p. 271.

[14] Jerome M. Pollack, op. cit., p. 18.

the basis of this fauna he established the age of the Harding as very late Chazyan or early Black River.

The position of Twenhofel on the status of the Harding is untenable to the author. It is true there is no basal conglomerate in the Fremont formation, but this does not prove that there is not a stratigraphic break between the Harding and the Fremont. Certainly the difference in the lithology and the very marked difference in the faunas of the two formations indicates a hiatus of considerable time between the deposition of the Harding and the overlying Fremont.

Overlying some sections of the Fremont formation in the embayment is the Devonian? Williams Canyon limestone. The Williams Canyon formation was described by Brainerd _et al._,[15] and they placed it in the Devonian period although they had no fossil evidence for this assignment. However, the Williams Canyon closely resembles the Parting formation of known Devonian age, which is present west of the embayment. On the basis of subsurface work in southeastern Colorado and western Kansas, Maher[16] has correlated the Williams Canyon with the Spergen limestone of that area and placed the Williams Canyon in the middle? Mississippian. As there is no concrete evidence for Maher's interpretation, the Williams

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[15] A. E. Brainerd, _et al._, _op._ _cit._, pp. 387-389.

[16] John C. Maher, _op._ _cit._, p. 1.

Canyon is considered herein as Devonian? according to the original description.

The contact between the Williams Canyon formation and the Fremont is unconformable in all sections where it is found. Along the road in Priest Canyon and in the section on Hardscrabble Creek the contact between the formations is easily discernible. In other sections, the contact between the two formations is difficult to locate.

In the Specimen Hill section the Fremont is overlain by the varicolored shales of the Jurassic Morrison formation. This relationship is probably the result of faulting as this section is very close to the northern end of the large Wet Mountains fault.

In most of the measured sections in the embayment the Fremont is overlain unconformably by the thick sequence of red arkosic sandstones of the Pennsylvanian Fountain formation. The contact is very irregular and is most cases the basal conglomerate of the Fountain is typified by well rounded, highly polished, yellow quartz cobbles.

The period following the deposition of the Fremont represents the greatest time lapse in the history of the embayment. No rocks of Silurian age, a few of questionable Devonian age and no rocks of Mississippian age are present within the embayment proper. This erosional period accounts for the change in thickness of the Fremont in some localities, and it was removed completely in some sections. The faunal evidence points to non-deposition of the lower Fremont in the area northeast of Phantom Canyon. In this area the fossils consist mainly of Lepidocyclus sp., Strophomena sp., and Ormoceras sp. These forms occur only in the upper part of the Fremont in the thicker sections to the southwest. It is known that parts of the Front Range were high areas during Paleozoic time and it is highly possible that in this area deposition of the formation by onlap is responsible for the relatively thin sections. Erosion has also removed portions of these thinner sections especially near the mouth of Phantom Canyon where the Fountain formation rests directly upon the pre-Cambrian granite.

The lithology of the Fremont formation is uniform excepting the thinner sections in the northeast part of the embayment. In the Garden Park area, where the thinner sections occur an intraformational conglomerate, which contains hard, dense, buff, dolomitic pebbles with a red, calcareous, silty matrix, is present near the top of the formation. This conglomerate occurs as thin beds through about 32 feet of the section. Northeast of Phantom Canyon in the North Lion Creek and Beaver Creek sections the beds in the lower 12 to 13 feet of the Fremont are a sandy dolomite, and locally thin sandstone lenses are present. This situation furnishes further evidence that the deposition of the Fremont formation in this area was a result of onlap relationship.

Sweet[17] has divided the Fremont formation into two members, the massive dolomite member and the Priest Canyon member, with the type locality in Priest Canyon. He makes this division on the basis of the fauna and lithology. Sweet's measurements for the two members at the type locality are 208.5 feet for the lower massive dolomite and 75 feet for the overlying Priest Canyon member. The massive dolomitic member is distinguishable according to him by its massive character. The overlying Priest Canyon member is described as a sequence of argillaceous, fine-grained, thin-bedded dolomite with a five-foot dolomitic shale bed constituting the basal unit.

A division of the Fremont on the basis of lithology does not seem feasible, however. The shale bed that Sweet[18] describes as the basal unit is not present in the embayment in any sections except those of Priest Canyon, South and North Twin Mt. Sweet[19] also implies that the strata above this shale bed are not very fossiliferous; however, during this work abundant fossils were found near the top of the formation, in the Priest Canyon, South and North Twin Mt. sections. As previously stated the sections northeast of

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[17]Sweet, op. cit., p. 295.

[18]Sweet, op. cit., p. 295.

[19]Sweet, Ibid., p. 295.

Phantom Canyon contain a fauna throughout which is closely related to that of the upper part of the Priest Canyon, North and South Twin Mt. sections. This is interpreted to mean that the lower portion of the Fremont, *i. e.* Sweet's massive member, was not deposited in the area northeast of Phantom Canyon.

According to Sweet[20] there are two prominent faunal horizons in the Fremont, one at or near the base of each of the members that he proposed. He states, "*Receptaculites*, *Halysites*, *Streptelasma*, *Calapoecia*, and *Endoceras* have been identified from the massive member in nearly every exposure studied and the combination of these forms makes this horizon a prominent one in the Paleozoic section of central Colorado. *Rhynchotrema* (*Lepidocyclus*)? *argenturbicum* is not uncommon in the massive dolomite in sections along the Front Range, and is particularly abundant near the mid-portion of the member at Specimen Hill, south of Cañon City."[21]

Results of this study do not agree with Sweet's conclusions relative to his faunal division of the two members. *Rhynchotrema argenturbicum* (White) was not identified from any other locality in the embayment other than the Specimen Hill section and there it occurs both at the top of the formation and in the middle portion. *Receptaculites* sp., considered an index of the massive member, was noted 210 feet above the

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[20] *Ibid.*, p. 300. [21] *Ibid.*, p. 301.

base of the Fremont at the type locality of Sweet, which would be within what he considers the Priest Canyon member. This form was not collected by the writer in the area northeast of Phantom Canyon, yet Sweet considers these sections to belong to the massive member. Halysites sp. and Calapoecia sp., two genera assigned to the massive member occur throughout the formation and are abundant near the top of the Fremont in the South and North Twin Mt. and Paradise Ridge sections. Ceraurinus icarus (Billings) which Sweet[22] lists as occurring 5-10 feet above the base of the Priest Canyon member was found by the writer 40 feet above the base of the Fremont at the Specimen Hill section.

Additional genera and species not in the lists of the fauna of the two members given by Sweet were found by the writer to occur in both upper and lower Fremont (refer to faunal chart, fig. 3). Thaerodonta saxea (Sardeson), a common form in the upper part of the Fremont in the South and North Twin Mt. and Priest Canyon sections, is also known from the so-called massive member in the Specimen Hill section. A prominent zone of Leperditella sp. is present about 10' above the base of the South Twin Mt. section and this same form is abundant at the top of the formation in the North Twin Mt. section in what would be Sweet's Priest Canyon member. Hemiphragma sp. and Saffordophyllum sp. are known from

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[22] Sweet, op. cit., p. 301.

beds near the top of the formation and also from beds below the dolomitic shale bed which is considered by Sweet as the basal unit of the Priest Canyon member.

The preceding evidence does not agree lithologically or faunally with the division of the Fremont formation into two members as proposed by Sweet.[23] There is a difference in the fauna of the lower Fremont from that of the upper, with the forms Ephippiorthoceras sp., Lichenaria sp., and Plaesiomys subquadratus occidentalis (Ladd) confined to the lower part, whereas Lepidocyclus sp., Strophomena sp., and most of the bryozoans and ostracods are limited to the upper portions of the formation. Beds which contain these fossils are not continuous throughout the embayment and it would be difficult to establish a definite zonation. The occurrence of these few diagnostic forms does not coincide with the zonation suggested by Sweet.[24]

The division of the Fremont formation into the massive dolomite member and the Priest Canyon member as proposed by Walter C. Sweet[25] is considered invalid and unworkable.

The Fremont formation has a lithological character, which according to criteria established by Dapples et al.,

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[23]Sweet, op. cit., p. 294.

[24]Ibid., p. 295.

[25]Ibid., p. 284.

is typical of deposition on a stable shelf.[26] The massive bedding, fine to medium to coarse crystalline texture, manner of preservation of the fossils, presence of chert, and other features of the Fremont formation resemble closely the description of a normal marine limestone which is deposited in a stable shelf environment.[27] The fauna of the Fremont, which includes corals, bryozoans, mollusks, brachiopods, ostracods, and trilobites, is consistent with the biologic attributes of a stable shelf environment.[28] These organisms are important as they influence the products of sedimentation. From physical evidence it is apparent that most of the shelf deposits have been formed in the shallow waters of the littoral and neritic zones, where the greatest abundance of benthonic forms occurs. The presence of the many corals and other forms suggests that the Fremont formation was deposited in a warm, shallow sea.

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[26] E. D. Dapples, W. C. Krumbein and L. L. Sloss, "Tectonic Control of Lithologic Associations," Bull. Amer. Assoc. Petroleum Geologists, Vol. 37, No. 11, p. 1932.

[27] Ibid., p. 1925.

[28] Ibid., p. 1925.

CHAPTER III

PALEONTOLOGY

The invertebrate fauna of the Fremont formation is large and diverse. Preservation of the fossils is poor and good specimens are the exception rather than the rule. From the silicified zone of North and South Twin Mts., however, some good specimens were obtained.

The following forms have been identified:

Coelenterata

Anthozoa

<u>Lichenaria</u> sp. indet.

<u>Saffordophyllum</u> sp. indet.

<u>Favistella</u> sp. indet.

<u>Palaeophyllum</u> <u>thomi</u> (Hall)

<u>Calapoecia</u> <u>coxi</u> Bassler

<u>Halysites</u> <u>gracilis</u> (Hall)

<u>Streptelasma</u> spp. indet.

Scyphozoa

Conularida

<u>Climacoconus</u> sp. indet.

Echinoderma

Crinoidea

Archaeocrinus sp. indet.

Bryozoa

Ectoprocta

Sceptropora huffmani, n. sp.

Hemiphragma sp. indet.

Rhombotrypa quadrata (Rominger)

Rhinidictya sp. indet.

Helopora imbricata Ulrich

Brachiopoda

Articulata

Plectorthis plicatella (Hall)

Plectorthis fissicosta (Hall)

Hebertella occidentalis sinuata (Hall)

Platystrophia sp. indet.

Glyptorthis crispata (Emmons)

Austinella cf. *A. whitfieldi* (Winchell)

Plaesiomys subquadratus occidentalis (Ladd)

Lepidocyclus cf. *L. rectangularis* Wang

Lepidocyclus sp. indet.

Hypsiptycha neenah (Whitfield)

Rhynchotrema argenturbicum White

Zygospira modesta (Say)

Strophomena spp. indet.

Thaerodonta saxea (Sardeson)

Mollusca

Gastropoda

<u>Lophospira</u> <u>medialis</u> (Ulrich and Scofield)

Cephalopoda

<u>Ephippiorthoceras</u> sp. indet.

<u>Ormoceras</u> sp. indet.

Arthropoda

Trilobita

<u>Ceraurus</u> <u>elginensis</u> Slocom

<u>Ceraurinus</u> <u>icarus</u> Billings

Ostracoda

<u>Bythocypris</u> <u>cylindrica</u> (Hall)

<u>Schmidtella</u> sp. indet.

<u>Paraparchites?</u> <u>subovatus</u>, n. sp.

<u>Leperditella</u> sp. indet.

<u>Leperditella</u> <u>aequilatera</u> (Ulrich)

<u>Leperditella</u> <u>sulcata</u> (Ulrich)

<u>Krausella</u> <u>inaequalis</u> Ulrich

<u>Hallatia</u> <u>healyensis</u> Kay

Sponge-like organisms

<u>Receptaculites</u> <u>oweni</u> Hall

Besides the forms listed above there are evidences of other forms, but the preservation is so poor that positive identification cannot be made. In the silicified zone there are many remains of a small spired form which resembles <u>Hormotoma</u> <u>gracilis</u> but no whole specimen was recovered. In the North Twin Mt. section there is evidence of some form of Beatricea but again preservation is so poor that no attempt was made to identify the specimens. Remains of gastropods and pelecypods are numerous in the Specimen Hill, Fremont Saddle, North Twin Mt., and South Twin Mt. sections.

From the preceding lists it is evident that the fauna of the Fremont formation contains both Mohawkian and Richmondian elements. It would be possible, indeed, if taken from a purely statistical basis, to place the age of the formation in the Trenton due to the presence of so many fossils with Trenton affinities. However, other workers have shown that the Richmond fauna typically shows many affinities with the Mohawkian fauna, and the newer elements of the Richmond are more important in this case than the "hold-overs" from the older fauna.

The fauna of the lower portion of the Fremont is mainly a molluscan fauna (seventeen genera of cephalopods are known from this portion[29]), with some corals and brachiopods. The upper portion of the formation has a fauna composed mainly of brachiopods, bryozoans, corals and arthropods. The mollusks in this part of the formation consist mainly of a few gastropods and only one genus of cephalopod was noted. The coral Halysites gracilis (Hall) ranges throughout the formation. There is no unconformity such as is present in the Viola formation of Oklahoma to account for the difference

[29]Sweet, op. cit., p. 303.

in the fauna. Environmental conditions were responsible for the highly fossiliferous thicker sections of the formation from the Specimen Hill section to Paradise Ridge, as compared to the thinner sections north and south of this area.

Kirk[30] (in Wilmarth) assigns all but the lower ten feet of the Fremont to the Richmond. The lower ten feet he assigns to the Trenton, and it is possible that he did this on the basis of the presence of Receptaculites following Ulrich's work on the Bighorn formation of Wyoming.[31] However, the presence of Halysites gracilis (Hall) in this zone indicates that it is Richmond in age also.

The lower portions of the Fremont formation contain many species which occur in the Red River formation of southern Manitoba and its equivalents. This formation and its equivalents according to Foerste,[32] are among the most remarkable of known Paleozoic formations because of their tremendous extension in a north-south direction, ranging from northwestern Greenland to the El Paso area of extreme western Texas. This late Ordovician invasion of the continent by

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[30] M. Grace Wilmarth, "Lexicon of Geologic Names of the United States," U. S. Geol. Survey, Bull. 896, 1938, p. 779.

[31] A. K. Miller, "Correlation of the Bighorn Formation of Wyoming," American Journal of Science, Fifth series, Vol. XX, No. 120, 1930, pp. 195-213.

[32] A. F. Foerste, "Big Horn and Related Cephalopods," Denison University Bulletin, Science Laboratory, Journal, Vol. 27, pp. 47-147, 1935.

waters originating in the Arctic brought a typical Richmond fauna associated with "holdovers" of the Mohawkian fauna into this area.

This fauna is found in the Red River formation of southern Manitoba, the Bighorn dolomite of Wyoming and is well developed in the Whitewood formation of South Dakota, the Stewartville formation of the upper Mississippi Valley, the Nelson River and Shammattawa formations of the Hudson Bay region, and the shale at Silliman's Fossil Mount on Baffin Island. Southern extensions of this fauna are present in the Viola formation of Oklahoma, the Montoya formation of western Texas and possibly the Burnham limestone of central Texas. The Fish Haven dolomite of Utah and southern Idaho is also closely equivalent. The faunas of the English Head, Vauréal and Ellis Bay formations of Anticosti Island are closely related to these formations. In fact the fauna of the Fremont formation finds its closest relationship with the Anticosti formations and with the Stony Mountain formation of Manitoba.

The genus Sceptropora was first identified by Ulrich,[33] from the Stony Mountain formation and this genus is represented in the Fremont by Sceptropora huffmani, n. sp. Sceptropora facula Ulrich, the genotype, is known from the English Head

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[33] E. O. Ulrich, "On Sceptropora, a New Genus of Bryozoa, with remarks on Helopora Hall, and other Genera of that type," The American Geologist, Vol. 1, 1888, p. 228.

and Vauréal formations of Anticosti Island,[34] and also occurs in the upper Ordovician formations of Percé, Quebec.[35] Many of the other fossils listed by Twenhofel as occuring in the Anticosti fauna, occur in the Fremont formation.

Miller,[36] suggests that the faunas of both the dolomites in the Bighorn formation are represented in the Fremont formation. He also points out that the Fremont and Montoya formations are the southern extensions of the Bighorn formation.

The brachiopod assemblage, some of the ostracods and the two trilobites that are known from the Fremont formation are also known from the Maquoketa formation of Iowa. Many of the forms that Wang,[37] reports in his study of the brachiopods of the Maquoketa are common in the Fremont. Ceraurus elginensis, which was originally described from the Maquoketa[38]

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[34]W. H. Twenhofel, op. cit., p. 160.

[35]Charles Schuchert and G. Arthur Cooper, "Stratigraphy and Paleontology of Percé, Quebec," American Journal of Science, Vol. 20, Fifth series, 1930, pp. 161-170.

[36]A. K. Miller, op. cit., p. 206.

[37]Y. Wang, "Maquoketa Brachiopoda of Iowa," Geological Society of America, Memoir 42, 1949, pp. 1-39, pls. 1-12.

[38]A. W. Slocom, "Trilobites from the Maquoketa Beds of Fayette, County, Iowa," Iowa Geological Survey, Annual Report, 1914, Vol. XXV, p. 224, pl. XVII, figs. 4-5.

by Slocom, and Ceraurinus icarus (Billings) both occur in the Fremont and these two forms are plentiful in the Maquoketa. Krausella inaequalis Ulrich and Leperditella sp. are two ostracods that occur in both the Maquoketa and the Fremont. Bythocypris cylindrica (Hall), Paraparchites? subovatus, n. sp., and Leperditella aequilatera (Ulrich) occur abundantly in the silicified zone of the Fremont and only in this horizon. These forms, which also are present in the Simpson group of Oklahoma, notably in the Bromide formation, are apparently long ranging and not too much significance can be attributed to this fact.

A great amount of work has been done by Foerste, Flower, Miller and others on the cephalopods of the so-called "arctic fauna" and an exact classification of this fauna is still a debated point. Foerste[39] regarded the age as Richmond. Flower[40] has shown that many of the boreal nautiloid genera appear for the first time in rocks that are of unquestioned late Trenton age. He further points out that there are a number of these genera that have not been found in formations of undisputed Richmond age. Kirk[41] suggested

[39] Foerste, op. cit., p. 63.

[40] Rousseau H. Flower, "New Ordovician Cephalopods from North America," Journal of Paleontology, Vol. 26, No. 1, 1952, p. 26.

[41] Edwin Kirk, "Notes on an Early Collection of Paleozoic Fossils from Ellesmereland," American Jour. of Sci., Fifth series, Vol. 10, 1925, pp. 445-547.

that the age of this boreal fauna is in a large part Cincinnatian (Covington in the restricted sense, as a division of the Cincinnatian including the Eden and Maysville and excluding Richmond). Flower[42] apparently agrees with this idea at least in part.

Kay[43] questions the classification of the Red River, Bighorn, Fremont, and similar formations as wholly Richmond. He believes they are wholly or principally Trentonian. The Fremont formation can be removed from this doubtful category as a result of the presence of recognized Richmondian forms: Halysites gracilis (Hall), Plaesiomys subquadrata occidentalis (Ladd), Ceraurinus icarus (Billings), Sceptropora huffmani, n. sp., Rhombotrypa quadrata (Rominger), Helopora imbricata Ulrich, Hemiphragma sp indet., Lepidocyclus rectangularis Wang, Thaerodonta saxea (Sardeson), Ceraurus elginensis Slocom, Paleophyllum thomi (Hall) and Calapoecia coxi Bassler. These forms indicate that the Fremont can be more accurately correlated with the English Head, Vauréal and Ellis Bay formations of Anticosti, the Stony Mountain formation of southern Manitoba and the Maquoketa formation of Iowa.

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[42] Flower, op. cit., p. 26.

[43] Marshall Kay, "Correlation of Ordovician Formations of North America," Bull. Geol. Soc. Amer., Vol. 65, No. 3, 1954, p. 282.

SYSTEMATIC DESCRIPTIONS

Phylum COELENTERATA

Class ANTHOZOA

Subclass TETRACORALLA Haeckel

Family FAVISTELLIDAE Chapman, 1914

Genus LICHENARIA Winchell and Schuchert, 1895

LICHENARIA sp. indet.

Pl. III, figs. 2a-c.

Corallum of many thin walled polygonal corallites in close contact. Corallites average 0.5 mm. in diameter. Corallites increase by bifurcation upward from the base of the colony, which is about 1 cm. in diameter in most specimens, with the upper part of the colony being 4 cm. or more in diameter. Septa absent. Tabulae present, especially in the lower part of the colony near the point of bifurcation where tabulae are closely spaced and well developed; tabulae a tube diameter apart in crowded zones and about twice that distance in the uncrowded region.

This coral is common in the lower units of the Fremont formation in the Priest Canyon and Twin Mt. sections, and seems to be limited in its distribution as it is not present elsewhere in the formation. Locality of figured specimens: Priest Canyon section, 10' and 50' above the base of the formation.

Genus SAFFORDOPHYLLUM Bassler, 1950

SAFFORDOPHYLLUM sp. indet.

Pl. II, figs. 15a-b.

Preservation of these specimens is so poor that specific identification cannot be determined. The corallum is a rounded mass several centimeters in diameter, composed of thin-walled, polygonal corallites 1 mm. wide; in polished sections and in the silicified portion of a large specimen, there is evidence of septa that protruded inward toward the center. It is not possible to determine accurately the number of septa that were present, but it appears that there were 12. Tabulae are well developed with two tabulae in a tube diameter in less crowded regions and five to six in the crowded zone. These corals closely resemble S. kiaeri Bassler. Figured specimen locality: Specimen Hill section 50' above the base of the formation.

Genus FAVISTELLA Dana, 1846

FAVISTELLA sp. indet.

Pl. II, fig. 16.

A fragment of a corallum is described here to show the occurrence of this genus in the Fremont formation.

The corallites are contiguous, united by their walls and are 4 mm. in diameter. Septa are thin and there are 12 primary septa and 12 secondary septa. Horizontal tabulae are present, with one to two in a tube diameter. Locality of figured specimen: Specimen Hill section, 50' from the base of the formation.

Genus PALAEOPHYLLUM Billings, 1858

PALAEOPHYLLUM THOMI (Hall)

Pl. III, figs. 5a-c.

Columnaria thomi HALL, 1857, Rept. U. S. Mexican Boundary Survey, Emory, Pl. 20, figs. 1a-d.
Palaeophyllum thomi (Hall). BASSLER, 1950, The Geological Society of America, Memoir 44, p. 275, Pl. 18, figs. 12-14, Pl. 19, fig. 12.

Corallum fasciculate with thick-walled corallites. Septa both primary and secondary, extending to the center. Tabulae complete and well developed with six in 5 mm. Walls are 1 mm. in width on larger corallums. Hypotype locality: Paradise Ridge section, top of the formation.

Genus CALAPOECIA Billings, 1865

CALAPOECIA COXI Bassler, 1950

Pl. III, figs. 1a-d.

Calapoecia canadensis COX, 1936, National Museum of Canada, Bull. 80, p. 10, pl. 2, figs. 2a, b.
Calapoecia coxi BASSLER, 1950, The Geological Society of America, Memoir 44, p. 276, pl. 20, figs. 5, 6; pl. 17, fig. 20.

This form occurs in various degrees of preservation throughout the Fremont formation. Some specimens occur as internal fillings of the original, some as the molds, and two preserving original characteristics were obtained. Distribution of these corals within the formation varies from locality to locality. Quite common in the sections west of Cañon City, they are typically absent in the sections north of Phantom Canyon and do not occur in the Specimen Hill section. They are most abundant in the upper beds of the formation.

The coralla are in most specimens massive, composed of rather equal, polygonal corallites. The walls of the corallites are quite thin in comparison to C. canadensis Billings, 1865, C. canadensis anticostiensis Billings, 1863, and C. canadensis anticostiensis forma artica Troedsson, 1928. Corallites are closely tabulated; tabulae are well developed and slightly curved; tabulae occur 5 in 4 mm. in the crowded zone, with 3 in 4 mm. in the less crowded zones. Septa are short, thick, and arranged back to back. Localities of figured specimens: Paradise Ridge, top of the formation; South Twin Mt., 90' from top of the formation; North Twin Mt., 50' from top of formation and from the face of the cliff formed by a sharp fold just above the silicified zone.

Family HALYSITIDAE

Genus HALYSITES Fischer, 1813

HALYSITES GRACILIS (Hall)

Pl. III, figs. 4a-d.

Catenipora gracilis HALL, 1851, Geol. Lake Sup. Land Dist., Foster and Whitney's Rep., p. 212, pl. 29, figs. 1a, b.
Halysites catenularia gracilis (Hall). WHITEAVES, 1897, Paleon. Foss., Geol. Surv. Canada, 3, pt. 3, p. 150.
Halysites catenulatus gracilis (Hall). SCHUCHERT, 1900, Proc., U. S. Nat. Mus., 22, p. 153.
Halysites gracilis (Hall). auct.

Corallum of cylindrical corallites, joined on their narrower sides, without an intervening minute tube as in H. catenularia. Corallites vary in size from 1 mm. to 1.5 mm. in width. Tabulae are strongly developed with 6 in 5 mm. in the smaller corallites and 5 in 5 mm. in the larger. Walls of corallites measure less than 0.4 mm. in thickness.

Many of these "chain corals" occur in the Fremont formation from the base to the top. The size of the colonies varies from a few inches to several feet in diameter. A portion of a large specimen in the fossil collection measures eight inches across the top and is seven inches high.

The specimens from the various units of the formation have been studied carefully and there is no apparent difference between any of the forms collected. Locality of figured specimen: Paradise Ridge, top of the formation.

Family STREPTELASMATIDAE Grabau, 1922

Genus STREPTELASMA Hall

STREPTELASMA spp. indet.

Pl. III, figs. 3a-c.

This genus is represented in the Fremont by two different forms. The preservation occurs in most cases as internal molds and identification of species would be most difficult. One form resembles S. profundum, and the other form is closely related to S. corniculum. These corals are abundant in the formation and occur in the thicker sections west of Cañon City throughout the formation. They are common in the upper part of the South Twin Mt. section. Locality of figured specimen: South Twin Mt., 90' from the top of the formation.

Class SCYPHOZOA

Group
CONULARIDA

Family CONULARIIDAE Walcott

Genus CLIMACOCONUS Sinclair, 1942

CLIMACOCONUS sp. indet.

Pl. IV, figs. 5a-b.

Two portions of the shell of a conularid were found in one piece of rock from the basal units of the Fremont in the Fremont Saddle section. The specimens closely resemble C. quadratus (Walcott).

The shell is small and tapering. Widest portion of the lateral face is 4 mm. Length of the larger specimen is 11 mm. with 13 transverse ridges occurring in that length. The ridges are smooth, highest halfway between the margins and the keel, with sharply rounded crests. The smaller specimen shows eight ridges in a length of 2 mm. and this is probably a portion of the shell close to the apex. Interspaces between the ridges are about one and a half times the size of the ridges.

Specimens of Climacoconus are rare, but occur in America throughout the Middle and Upper Ordovician, from the Chazy to the Richmond. Locality of figured specimen: Base of the Fremont, Fremont Saddle section.

Phylum ECHINODERMA

Class CRINOIDEA

Subclass CAMERATA

Order DIPLOBATHRA

Family ARCHAEOCRINIDAE

Genus ARCHAEOCRINUS Wachsmuth and Springer, 1881

ARCHAEOCRINUS sp. indet.

Pl. IV, fig. 15.

A form in which only generic characteristics are discernible was recovered from the Specimen Hill section and subsequently identified as a species of Archaeocrinus Wachsmuth and Springer. Only one poorly preserved specimen is available for study. Strong affinities with Archaeocrinus are exhibited by the character and arrangement of the plates. Locality of figured specimen: Specimen Hill section, top of the formation.

Phylum BRYOZOA

Subphylum ECTOPROCTA

Class GYMNOLAEMATA

Order CRYPTOSTOMATA Vine, 1883

Family ARTHROSTYLIDAE Ulrich, 1888

Genus SCEPTROPORA Ulrich, 1888

SCEPTROPORA HUFFMANI, n. sp.

Pl. I, figs. 3a-d.

Sceptropora was founded upon a single species, S. facula (Ulrich) from the Richmond rocks of Manitoba, Canada. This form has since been found in Richmond strata at many other localities. A portion of Ulrich's original description is given here.

Segments club-shaped, varying in length from less than 1 mm. to nearly 2 mm; lower half subcylindrical, about 0.23 mm. in diameter, non-celluliferous, covered with fine, granulose, vertical striae; lower extremity bulbous smooth; upper half celluliferous, expanding more or less rapidly, the depressed conical top varying in diameter from 0.7 mm. to 2 mm. The apertures of the zooecia on the top are subcircular; about 0.09 mm. in diameter and arranged in radial series between raised lines about the large central socket. As the zoarium expands the series increase in number by interpolation. The apertures of the zooecia on the sides are ovate and a little larger than those on the top and are arranged between the elevated granulose ridges.

S. huffmani resembles S. facula in external appearance, but on the average the segments are smaller, varying in length from 0.5 mm. to 1 mm. in length. In thin section, however, this new species differs quite markedly from S. facula. Zooecia of S. facula are expanded in the transverse section while those of S. huffmani are straight. In vertical section the walls of the zooecial tubes of S. facula are only slightly curved, while the wall of this new species extends straight out from the central axis, then curves sharply upward, then straightens out almost parallel to the first straight part of the wall. The apertures of the zooecia are sub-circular; about 0.05 mm. in diameter, and are arranged in radial series with seven zooecia in 1.2 mm. Between the large zooecia are small apertures which do not extend to the central axis, giving them the appearance of mesopores. These, however, are probably only young zooecia.

This species is named in honor of Dr. George G. Huffman, Associate Professor of Geology at the University of Oklahoma. Holotype to be deposited in the University of Oklahoma Paleontology Collections.

Sceptropora huffmani is common in the silicified zone of the North and South Twin Mt. sections and is not known from any other part of the formation. Holotype locality: Silicified zone, 50' from top of formation, South Twin Mt. section.

Order TREPOSTOMATA Ulrich, 1882

Suborder INTEGRATA Ulrich and Bassler, 1904

Family TREMATOPORIDAE Miller, 1889

Genus HEMIPHRAGMA Ulrich, 1893

HEMIPHRAGMA sp. indet.

Pl. I, figs. 4a-c.

Many of these large, robust, forms occur as internal fillings, and as external molds of the original specimens. The size of the branches varies from 8 mm. to 33 mm. in length. Zooecia subpolygonal, seven in 2 mm.; some specimens show aggregations of larger cells surrounding smaller mesopores?. These forms closely resemble H. imperfectum (Ulrich). Locality of figured specimen: South Twin Mt. section 90' from the top of the formation.

Family AMPLEXOPORIDAE Miller, 1889

Genus RHOMBOTRYPA Ulrich and Bassler, 1904

RHOMBOTRYPA QUADRATA (Rominger)

Pl. I, figs. 1a-c.

Chaetetes quadratus ROMINGER, 1866, Proc. Acad. Nat. Sci. Philadelphia, p. 116.
Rhombotrypa quadrata (Rominger). NICKLES, 1905, Kentucky Geol. Survey., series 5, p. 58, pl. 3, fig. 11.

Irregular cylindrical branches, varying in size from 3 mm. to 7 mm.; tubes rhombic in section, arranged in curved diagonal lines; zooecial walls rather thick; acanthopores lacking. Longitudinal section shows numerous diaphragms in mature region. Mesopores absent.

This species is common in the silicified zone of North and South Twin Mt. sections. It also occurs lower in the section as molds of the original material. Figured specimen locality: South Twin Mt. section, 50' from the top of the formation.

Family RHINIDICTYIDAE Ulrich, 1895

Genus RHINIDICTYA Ulrich, 1892

RHINIDICTYA sp. indet.

Pl. I, figs. 5a-b.

Zoarium small, branches 0.8 mm. wide. Zooecia in five longitudinal rows. Apertures small and rectangular, with continuous striae separating the apertures into longitudinal rows; two apertures in 1 mm. Locality of figured specimen: Silicified zone, South Twin Mt. section, 50' from the top of the formation.

Family ARTHROSTYLIDAE Ulrich, 1888

Genus HELOPORA Hall, 1851

HELOPORA IMBRICATA Ulrich, 1890

Pl. I, figs. 2a-b.

Helopora imbricata ULRICH, 1890, Geol. Surv., Illinois, Vol. VIII, p. 644, Pl. XXIX, fig. 5.
Helopora imbricata (Ulrich). BASSLER, 1927, "Bryozoa" (Silurian, Anticosti): Can. Geol. Survey, Mem. 154, p. 159.

This form occurs mainly as isolated segments, but in one or two cases four segments joined together were noted. Like other genera of this family they are extremely delicate and are commonly broken upon removal from the matrix.

Segments have a rough aspect, with the zooecia arranged in vertical series around the segment, in most specimens numbering eight. Zooecial apertures subcircular; segments are small, normally about 3 mm. in length and pointed on the lower extremity. The segments are 0.5 mm. in diameter. Hypotype locality: Silicified zone, South Twin Mt., section 50' from the top of the formation.

Phylum BRACHIOPODA

Class ARTICULATA

IMPUNCTATE ARTICULATA

Superfamily ORTHACEA Walcott and Schuchert, 1908

Family PLECTORTHIDAE Schuchert and Cooper, 1930

Subfamily PLECTORTHINAE Schuchert, 1929, emended

Genus PLECTORTHIS Hall and Clarke, 1892

PLECTORTHIS PLICATELLA (Hall), 1847

Pl. II, figs. 1a-b.

Orthis plicatella HALL, 1847, Paleontology New York, I, p. 122, pl. 32, fig. 9.

Plectorthis plicatella (Hall). HALL and CLARKE, 1892, Paleontology New York, VIII, Pt. I, p. 221, pl. 5, figs. 18-20.

Plectorthis plicatella (Hall). SCHUCHERT and COOPER, 1932, Mem. Peabody Museum of Natural History, Vol. IV, Pt. I, p. 58.

Several specimens have been found preserved as molds of the ventral exterior. Shell outline biconvex and transversely semielliptical. Characterized by strong unbifurcated costae; 25 costae along the margin. Hypotype locality: South Twin Mt., 90' from top of formation.

PLECTORTHIS FISSICOSTA (Hall), 1847

Pl. II, fig. 2.

Orthis fissicosta HALL, 1847, Paleontology New York, I, p. 121, pl. 32, fig. 7.
Plectorthis fissicosta (Hall). SCHUCHERT and COOPER, 1932, Mem. Peabody Museum of Natural History, Vol. IV, Pt. 1, p. 58.

This species is distinguished from P. plicatella by the bifurcated costae along the front margin. Addition of secondary plications starts at a distance of about 10 mm. from the beak while the primary plications continue more conspicuously to the anterior margin. Shell small, moderately convex, semi-oval in outline; ventral valve has greatest convexity near the umbo, then slopes forward and laterally to form a shallow sinus on the anterior margin. Hypotype locality: Silicified zone, South Twin Mt., 50' from top of formation.

Genus HEBERTELLA Hall and Clarke, 1892

HEBERTELLA OCCIDENTALIS SINUATA (Hall), 1847

Pl. II, figs. 3a, b.

Orthis sinuata HALL, 1847, Paleontology New York, I, p. 128, pl. 32B, fig. 2.
Orthis occidentalis sinuata (Hall). MEEK, n. comb., 1873, Paleontology Ohio, I, p. 98.
Hebertella sinuata (Hall). HALL and CLARKE, 1892, Paleontology New York, VIII, Pt. I, p. 222, pl. 5A, figs. 1-8.
Hebertella occidentalis sinuata (Hall). SCHUCHERT and COOPER, 1932, Mem. Peabody Museum of Natural History, Vol. IV, Pt. I, p. 60, pl. 11, figs. 14, 17, 19-26.

This is a small form of the genus Hebertella. Valves unequally biconvex in profile; cardinal extremities rounded; anterior commissure uniplicate; hinge-line straight and narrower than the greatest width; ornamentation multicostate; dorsal valve much deeper than the ventral, with a strong fold. Hypotype locality: Silicified zone, South Twin Mt., 50' from top of the formation.

Subfamily PLATYSTROPHIINAE Schuchert, 1929

Genus PLATYSTROPHIA King, 1850

PLATYSTROPHIA sp. indet.

Pl. II, fig. 4.

Figured specimen preserved as the internal mold and part of the mold of the original shell. Specimen too poorly preserved to make specific identification. Mold of original shell shows part of one flank and portions of the three large costae in the sulcus. Costae strong and very lamellose. Internal mold is about one half the original and shows the four strong costae on the fold and the three costae in the sulcus. Resembles Platystrophia laticosta (Meek) in size and number of costae (7) on the flanks. Locality of figured specimen: South Twin Mt., 90' from top of formation.

Family ORTHIDAE Woodward, 1852, emended

Subfamily GLYPTORTHINAE Schuchert and Cooper, 1931

Genus GLYPTORTHIS Foerste, 1914

GLYPTORTHIS CRISPATA (Emmons), 1842

Pl. II, figs. 5a-b.

Orthis crispata EMMONS, 1842, Geology New York; Rep. Second Dist., p. 404, fig. 5.
Dalmanella crispata (Emmons). HALL and CLARKE, 1892, Paleontology New York, VIII, Pt. I, p. 224.
Glyptorthis crispata (Emmons). FOERSTE, 1914, Bull. Sci. Lab., Denison Univ., Vol. 17, p. 258, pl. III, fig. 9.

Small (about 14 mm. long), subquadrate, valves subequal in convexity; dorsal valve slightly sulcate; surface marked by angular plications, 5 in a width of 5 mm. along the anterior margin of the shell; concentric striae strongly lamellose. Hypotype locality: Silicified zone, South Twin Mt., 50' from top of formation.

Family DINORTHIDAE Schuchert and Cooper, 1932

Genus AUSTINELLA Foerste, 1909

AUSTINELLA cf. A. WHITFIELDI (Winchell), 1881

Pl. II, figs. 7a-b.

Orthis whitfieldi WINCHELL, 1881, Geol. and Natural History Survey, 9th Ann. Rept., Minn., p. 115.
Plectorthis whitfieldi (Winchell). HALL and CLARKE, 1892, Paleontology New York, VIII, Pt. I, p. 221, pl. 5, fig. 26.
Austinella sp. (Foerste). SCHUCHERT and COOPER, 1932, Mem. Peabody Museum Natural History, Vol. IV, Pt. I, p. 99, pl. 9, fig. 12.
Austinella whitfieldi (Winchell). WANG, 1949, Geol. Soc. Amer., Memoir 42, p. 8, pl. 2A, figs. 1-7.

A specimen poorly preserved as the external mold of the ventral valve. Ornamentation multicostate; costae strong, subrounded and separated by deep interspaces. Costae increase by intercalation and bifurcation. Because of the nature of the preservation it is hard to ascertain whether there are three generations of intercalation and bifurcation such as occurs in A. whitfieldi (Winchell). The size of the shell, the ornamentation and number of costae in this specimen closely resemble the description of A. whitfieldi as given by Wang. Locality of figured specimen: South Twin Mt., 90' from top of formation.

Genus PLAESIOMYS Hall and Clarke, 1892

PLAESIOMYS SUBQUADRATUS OCCIDENTALIS (Ladd), 1929

Pl. II, fig. 6.

Dinorthis (Plaesiomys) subquadrata occidentalis LADD, 1929, Iowa Geol. Survey, Ann. Rept., Vol. 34, p. 402-403, pl. 5, figs. 7-9.
Plaesiomys subquadratus occidentalis (Ladd). WANG, 1949, Geol. Soc. Amer., Memoir 42, p. 5, pl. 2D, figs. 1-5.

This species is represented by one specimen which is the mold of the dorsal valve. Dorsal valve broadly convex with a moderately deep sulcus that originates at the beak and expands anteriorly. Ornamentation multicostate; 54 costae along margin, a number of them bifurcated two or three times; secondary costae strong. Hypotype locality: Specimen Hill, top of the formation.

Superfamily RHYNCHONELLACEA Schuchert, 1896

Family RHYNCHONELLIDAE Gray, 1848

Genus LEPIDOCYCLUS Wang, 1949

LEPIDOCYCLUS cf. L. RECTANGULARIS Wang, 1949

Pl. II, figs. 9a-b.

Lepidocyclus rectangularis WANG, 1949, Geol. Society of America, Memoir 42, p. 15, pl. 5A, figs. 1-8.

This species is common in the upper part of the Fremont formation in the Priest Canyon, South and North Twin Mt. sections. Although no good complete specimens were recovered, the molds of the original material were excellent and gave good casts of both the dorsal and ventral valves. The ventral valve is subtriangular to subpentagonal in outline; sulcus is broad anteriorly, marked by three costae; ventral lateral areas marked by 12 costae; zigzag lamellae on surface are strong. Dorsal valve has a relatively high fold anteriorly, but is depressed posteriorly; fold marked by four costae; zigzag lamellae on surface strong; dorsal lateral areas more convex than the ventral ones and marked by 10 or 11 costae. Hypotype locality: South Twin Mt., 90' from top of formation.

LEPIDOCYCLUS sp. indet.

Pl. II, fig. 11.

Preservation of these specimens is too poor to attempt a specific identification. Casts taken from the two molds show marked relationship with Lepidocyclus species and in particular, L. capax. Large, globose, with costate ornamentation. One specimen shows development of the fold and sinus with four costae on the fold and three in the sinus. Fine zigzag lamellae on the entire surface. This form is common in the basal unit of the Fremont in the Beaver Creek section and is one of the few fossils that were obtained from this locality. Locality of figured specimen: Base of the Fremont, Beaver Creek section.

Genus HYPSIPTYCHA Wang, 1949

HYPSIPTYCHA NEENAH (Whitfield), 1882

Pl. II, figs. 12a-c.

Rhynchonella neenah WHITFIELD, 1882, Geol. Wisconsin, IV, p. 265, pl. 12, figs. 19-22.
Rhynchonella (?) neenah (Whitfield). WINCHELL and SCHUCHERT, 1893, Geol. Survey Minnesota, III, p. 465, pl. 34, figs. 35-37.
Hypsiptycha neenah (Whitfield). WANG, 1949, Geol. Soc. Amer., Memoir 42, p. 18, pl. 10C, figs. 1-6.

Shell small, with strongly globose profile, lateral profile unequally biconvex, dorsal valve having the greatest convexity. Hinge line narrow. Anterior commissure uniplicate. Highly elevated fold, narrow, disappearing near umbo, marked by four costae, the lateral two obscure and visible only on the sides of the fold. Sulcus is deep, occupying one-third the width, elevated posteriorly; marked by three costae. Dorsal lateral areas more convex than the ventral ones, and each ornamented by eight costae. Entire surface is covered with fine zigzag lamellae. These forms are common to the upper part of the Specimen Hill section and are silicified. Hypotype locality: Specimen Hill, top of the formation.

Genus RHYNCHOTREMA Hall, 1860

RHYNCHOTREMA ARGENTURBICUM (White)

Pl. II, figs. 10a-c.

Rhynchonella argenturbica WHITE, 1875, Wheeler's Geol. and Geog. Survey West 100th Merid., 4, Prel. Rep., p. 14.
Rhynchotrema argenturbicum (White). SHIMER and SHROCK, 1944, Index Fossils of North America, p. 309, pl. 118, figs. 4-6.

Small, subtriangular, widest anteriorly; profile subequally biconvex. Anterior commisure uniplicate; fold high anteriorly, becoming depressed near the beak; sulcus moderately deep, width equal throughout; elevated posteriorly. Surface costae angular, four on fold, three in sulcus and six on lateral areas. Differs from Lepidocyclus in the fact that there are no zigzag lamellae on the surface. The form is present only in Specimen Hill section. Hypotype locality: Specimen Hill section, top of the formation.

Superfamily SPIRIFERACEA Waagen, 1883

Family ATRYPIDAE Gill, 1871

Subfamily ZYGOSPIRINAE Hall and Clarke, 1895

Genus ZYGOSPIRA Hall, 1862

ZYGOSPIRA MODESTA (Say) Hall, 1862

Pl. II, figs. 13a-b.

Atrypa modesta (Say). HALL, 1847, Paleontology New York, I, p. 141, pl. 15, fig. 15.
Zygospira modesta (Say). HALL, 1862, 15th Rep. New York State Cab. Nat. Hist., p. 154.

Shell small, 7.3 mm. wide, 8 mm. long, rostrate and biconvex. Dorsal valve with sinus occupied by three plications, seven plications on lateral areas. Ventral valve with low median fold, four plications on fold. Costae rounded, equal in size and extending from beak to lateral margin. Common in Specimen Hill section and in silicified zone of the South Twin Mt., section. Hypotype locality: Specimen Hill section, top of the formation.

PSEUDOPUNCTATE ARTICULATA

Superfamily STROPHOMENACEA Schuchert, 1896

Family STROPHOMENIDAE King, 1846

Genus STROPHOMENA Blainville, 1825

STROPHOMENA spp. indet.

Pl. II, figs. 8a-b.

Forms of this genus are numerous in the Fremont formation but the preservation is too poor to make specific identification. An interior of the dorsal valve and an exterior of a dorsal valve of different species are figured.

Dorsal valve convex with greatest convexity around the middle; sockets prominent; median ridge short and stout. Dorsal exterior costellate with costellae of equal size; intercalations appearing repeatedly down slope of geniculation; growth lamellae strongly developed. Figured specimens localities: North Twin Mt., 40' from top of the formation; South Twin Mt., 90' from top of the formation.

Genus THAERODONTA Wang, 1949

THAERODONTA SAXEA (Sardeson), 1892

Pl. II, figs. 14a-b.

Leptaena saxea SARDESON, 1892, Minn. Acad. Nat. Sci., Vol. 3, p. 330, pl. 4, figs. 33-35.
Thaerodonta saxea (Sardeson). WANG, 1949, Geol. Soc. Amer., Memoir 42, p. 21, pl. 11B, figs. 1-5.

Shell moderately large, 23 mm. wide; outline subrectangular. Hinge line straight, forming the greatest shell width. Surface unequally costellate, 4 to 6 fine costellae grouped between two stronger ones; growth lines visible.

Ventral interior shows median septum extending anteriorly about a third of the length, then bifurcating anterolaterally. muscle field bilobed anteriorly.

Dorsal valve unknown.

Species of this genus have usually been assigned to Sowerbyella. Wang makes a distinction between Sowerbyella and Thaerodonta on size and on several important differences in the internal characters. The Fremont specimens agree closely in size and internal characteristics with Thaerodonta. Although the preservation is poor and the dorsal valve is unknown the evidence points to the described form rather than to forms of Sowerbyella. Localities of figured specimens: Ventral interior from Specimen Hill section, top of the formation. Ventral exterior from South Twin Mt., 90' from top of formation. Known also from Priest Canyon and Harding's quarry.

Phylum MOLLUSCA

Class GASTROPODA

Subclass EUGASTROPODA

Superorder PROSOBRANCHIA

Order ARCHAEOGASTROPODA

Genus LOXOPLOCUS Fischer, 1885

Subgenus LOPHOSPIRA Whitfield, 1886

LOXOPLOCUS (LOPHOSPIRA) MEDIALIS (Ulrich and Scofield), 1897

Pl. IV, fig. 4.

Lophospira medialis ULRICH and SCOFIELD, 1897, Geol. Minn., 3, pt. 2, p. 973, pl. 73, figs. 23-29.

This species is known from a portion of an internal mold. Height of the specimen is 21 mm., with six contiguous volutions. Volutions are rounded below; upper slope nearly flat, generally a little concave in the outer half and gently convex toward the suture; umbilicus small but present; last whorl partly out of contact. Surface ornamentation not preserved.

In the thicker sections of the Fremont formation gastropod remains are quite common. However, due to the type of preservation no good specimens were obtained except the above described form. The lower units of the Priest Canyon, Specimen Hill and South Twin Mt. sections have a great many molds of gastropods, resembling forms of Maclurites, but they are practically impossible to get out of the rock. In the silicifaed zone of South Twin Mt. section some microscopic gastropods were obtained in the residue from the acid bath. These forms are probably nepionic and were not considered by the author because positive identification cannot be made.

Class PELECYPODA

Pelecypod remains are present in the Fremont formation but unfortunately are so poorly preserved that no specimens were obtained. Some silicifed nepionic forms were obtained in residues but generic and specific identification is not feasible.

Class CEPHALOPODA

Order MICHELINOCERATIDA

Genus EPHIPPIORTHOCERAS Foerste, 1925

EPHIPPIORTHOCERAS sp. indet.

Pl. IV, fig. 3.

A partially preserved specimen from the altered zone of the basal Fremont. Specimen 75 mm. long with 12 camerae in a length of 58 mm. At the base of the specimen the center of the siphuncle is 6 mm. from the ventral wall, while at the top of the specimen the siphuncle is 11 mm. from the ventral wall. The septa are concave and are more concave on the ventral side. No trace of surface ornamentation remains. Locality of figured specimen: South Twin Mt. section, 10' above the base of the formation.

Order ACTINOCERATIDA

Genus ORMOCERAS Stokes

ORMOCERAS sp. indet.

Pl. IV, figs. 2a-b.

Poorly preserved specimen showing a portion of the siphuncle; segments of siphuncle spheroidal, averaging 5 mm. in height; siphuncle lies close to the convex side of the shell. Figure 2b is a view of a specimen from the collection of Dr. Flower which shows the shell of a form of this genus. Locality of figured specimen, 2a: South Twin Mt., 90' from top of the formation.

Phylum ARTHROPODA

Class CRUSTACEA

Subclass TRILOBITA

Order PROPARIA

Superfamily CHEIRURIDAE Opik, 1937

Family CHEIRURIDAE Hawle and Corda, 1847

Subfamily CHEIRURINAE Raymond, 1913

Genus CERAURUS Green, 1832

CERAURUS ELGINENSIS Slocom, 1913
Pl. IV, figs. 6a-c.

Ceraurus elginensis SLOCOM, 1913, Field Mus. Nat. Hist., Geol. Ser., Vol. 4, p. 73, pl. XVII, figs. 4-5.
Ceraurus elginensis Slocom. SLOCOM, 1916, Iowa Geol. Survey, Vol. XXV, Ann. Rep. 1914, p. 224, pl. XVIII, figs. 4-5.
Ceraurus elginensis Slocom. WALTER, 1923, Iowa Geol. Survey, Ann. Rep. 1923, 1924, p. 245, pl. XIX, fig. 10.

Cephalon sublunate, width more than three times the length. Glabella convex, clavate, less than half the width of the cheeks at its posterior margin but gradually widening anteriorly until its width nearly equals its length; anterior lobe constituting almost one-fourth the entire length of the glabella; three pairs of lateral furrows, rather short, well defined, defining three pairs of convex lateral lobes, which diminish in size posteriorly; the two anterior pairs of furrows are transverse, the posterior pair are transverse for part of their length, then bend backward until they join the occipital furrow, isolating the posterior lobes; occipital segment elevated at the posterior margin, sloping into the occipital furrow; occipital furrow shallow, concave in the median portion, narrower, deeper and bent backward behind the glabellar lobes; dorsal furrows deep, angular, forming deep angular pits where they merge into the marginal furrows; cheeks large; palpebral lobes elongated, large for the genus, placed well forward and nearer the posterior margins than the dorsal furrows; the facial sutures originate on the lateral margins about in line with the posterior marginal furrow, curve forward and inward to the palpebral lobes, which they traverse, then forward to the anterior margin which they reach in front of the glabella; free cheeks small, less than one-third the size of the fixed cheeks. The surface of the glabella is covered with more or less regularly distributed rounded tubercles; flattened areas of the genal spines have tubercles distributed over them and apparently the tubercles decrease posteriorly along the spine.

Thorax and pygidium not known. Hypotype locality: North Twin Mt. section, 40' from top of the formation.

Genus CERAURINUS Barton, 1913

CERAURINUS ICARUS (Billings), 1860

Pl. IV, fig. 7.

Cheirurus icarus BILLINGS, 1860, Can. Nat. and Geol., Vol. 5, p. 67, fig. 2.
Ceraurus icarus (Billings). MEEK, 1873, Paleontology Ohio, Vol. I, p. 162, pl. 14, figs. 11a-c.
Ceraurus meekanus S. A. MILLER, 1889, North American Geol. and Paleont., p. 537.
Eccoptochile meekanus (Miller). SLOCOM, 1913, Field Mus. Nat. Hist., Geol. Ser., Vol. 4, p. 75, pl. XVII, figs. 6-9.
Ceraurinus icarus (Billings). SLOCOM, 1916, Iowa Geol. Survey, Vol. XXV, Ann. Rep. 1914, p. 227, pl. XVIII, figs. 6-9.
Ceraurinus icarus (Billings). WALTER, 1923, Iowa Geol. Survey, Vol. XXXI, Ann. Rep. 1923, 1924, p. 251, pl. XX, figs. 10-13.

This species is identified from a mold of the glabella. Glabella subquadrate, rounded in front. Anterior lobe of the glabella transversely oval, about twice as wide as long, lateral lobes nearly transverse and about equal in size. Glabellar furrows distinct, length about one-third the width of the glabella, anterior pair bent backward, middle pair nearly at right angles to the axis of the glabella; posterior pair similar to the middle pair for most of the length but having the inner ends abruptly bent backward isolating the posterior glabellar lobes.

Thorax and pygidium unknown. Hypotype locality: Specimen Hill section, 40' from the base of the formation.

Subclass OSTRACODA

Family BAIRDIIDAE Sars

Genus BYTHOCYPRIS Brady, 1880

BYTHOCYPRIS CYLINDRICA (Hall), 1872

Pl. IV, figs. 10a-b.

Leperditia (Isochilina) cylindrica HALL, 1872, Twenty-fourth Rep. State Cab. N. Y., p. 231, pl. VIII, fig. 12.
Isochilina cylindrica Hall. MILLER, 1875, Cin. Quart. Jour. Sci., Vol. II, p. 351.
Bythocypris cylindrica (Hall). ULRICH, 1889, Contri. Can. Micro-Paleont., p. 2, p. 48. (Not pl. IX, fig. 6).

Carapace smooth, more or less reniform; left valve larger than the right, overlapping it on both the dorsal and ventral margins; dorsal margin strongly convex, ventral margin slightly concave. Length, 1.5 mm., height 0.5 mm., thickness 0.3 mm. Hypotype locality: Silicified zone, South Twin Mt. section, 50' from top of the formation.

Family LEPERDITELLIDAE Ulrich and Bassler

Genus SCHMIDTELLA Ulrich, 1892

SCHMIDTELLA sp. indet.

Pl. IV, figs. 8a-b.

Carapace small; subovate, broadly umbonate; most convex in dorsal region and pinched in ventral slope, right valve overlaps the left valve ventrally. Length 0.275 mm., height 0.20 mm., thickness 0.175 mm. Locality of figured specimen: Silicified zone South Twin Mt., 50' from top of the formation.

Genus PARAPARCHITES Ulrich and Bassler

PARAPARCHITES ? SUBOVATUS, n. sp.

Pl. IV, figs. 11a-b.

Carapace large, subcircular, ventral edge of right valve overlaps the beveled edge of the left valve; dorsal edge of left valve overlapping right valve. Eye tubercle or a possible spine base, poorly preserved, on left valve only; valves smooth, equal in convexity; Measurements of holotype: length 1 mm., height 0.75 mm., thickness of both valves 0.5 mm.

This form, common in the silicified zone of the Fremont formation, is also known from the Bromide formation of Oklahoma.[44] According to Bassler and Kellett,[45] the range of the genus Paraparchites is Devonian to Permian. The characteristics of this new species indicate, however, that it is a form of this genus.

Holotype to be deposited in the University of Oklahoma Paleontological Collections. Holotype locality: South Twin Mt. section, 50' from the top of the formation. (The name,

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[44] R. W. Harris, personal communication, May, 1954.

[45] Ray S. Bassler and Betty Kellett, "Bibliographic Index of Paleozoic Ostracoda," Geol. Soc. Amer., Special Paper No. 1, 1934, p. 423.

subovatus, is formed from the Latin: sub, nearly; and, ovatus, egg-shaped).

Genus LEPERDITELLA Ulrich, 1894

LEPERDITELLA AEQUILATERA (Ulrich), 1892

Pl. IV, figs. 13a-b.

Leperditia aequilatera ULRICH, 1892, American Geologist, Vol. 10, p. 265, pl. 9, figs. 9-11.
Leperditella aequilatera (Ulrich). ULRICH, 1894, Geol. Minn., 3, pt. 2, p. 636, fig. 46i.

Carapace short, slightly oblique, dorsal margin straight almost the length of the carapace, angles distinct; ends subequal, rounding almost uniformly into the basal outline; carapace moderately convex except in the last third of the anterior end, where it becomes slightly compressed; surface ornamentation lacking. Hypotype locality: Silicified zone, South Twin Mt. section, 50' from the top of the formation.

LEPERDITELLA SULCATA (Ulrich), 1892

Pl. IV, fig. 14.

Leperditia sulcata ULRICH, 1892, American Geologist, Vol. 10, p. 266, pl. 9, figs. 19-21.
Leperditella sulcata (Ulrich). ULRICH, 1894, Geol. Minnesota, 3, pt. 2, p. 636, fig. 46j.

Carapace large, suboval in outline, widest posteriorly; posterior tumid; point of greatest thickness a little behind the center. Highest in the posterior half, then sloping down to the hinge line. Very distinct sulcus extending half across the valve from the central part of the dorsal edge. Length 2.7 mm., height 2 mm., thickness, 1 mm. Hypotype locality: Silicified zone, South Twin Mt., 50' from top of formation. This species occurs also near the top of the Fremont in the North Twin Mt. section.

Family BEECHERELLIDAE

Genus KRAUSELLA Ulrich, 1894

KRAUSELLA INAEQUALIS Ulrich, 1894

Pl. IV, fig. 9.

Krausella inaequalis ULRICH, 1894, Geol. Minnesota, 3, pt. 2, pl. 44, figs. 44-46.

Carapace elongate, the ventral margin nearly straight and longer than the dorsal; dorsal margin evenly and moderately arched. Ends are equally rounded. Valves thick and unequal with the larger (left) valve overlapping the other. The posterior end is projected into a short, round spine. Length 2.5 mm., height 2 mm., thickness 1 mm. Hypotype locality: Silicified zone, South Twin Mt. section, 50' from top of the formation.

Family PRIMITIIDAE Ulrich and Bassler, 1923

Genus HALLATIA Kay, 1934

HALLATIA HEALEYENSIS Kay, 1934

Pl. IV, figs. 12a-b.

Hallatia healeyensis KAY, 1934, Journal of Paleontology, Vol. 8, No. 3, p. 335, pl. 45, figs. 5-6.

Hallatia healeyensis Kay. SWARTZ, 1936, Journal of Paleontology, Vol. 10, No. 7, p. 549, pl. 79, fig. 7.

Carapace relatively small, valves equal. Outline a dorsally truncated ellipse; margin regularly curved; hinge line long. Surface smooth, with a distinct median sulcus, with sharp borders on ventral and posterior ends.

This form is the most common ostracod in the silicified zone of the Fremont formation. Hypotype locality: Silicified zone, South Twin Mt. section, 50' from the top of the formation.

Phylum PORIFERA

SPONGE-LIKE ORGANISMS

Genus RECEPTACULITES Defrance, 1827

RECEPTACULITES OWENI Hall

Pl. IV, fig. 1.

Receptaculites oweni HALL, 1861, Rep. Supt. Geol. Surv. Wisc., p. 11-13.

This sponge-like fossil is abundant in the lower portion of the Fremont formation in all sections except those north and east of Phantom Canyon, where it does not occur. Isolated specimens have been noted 90 to 130 feet above the base in the South Twin Mt. section and about 200' above the base in the Priest Canyon section.

Most of the forms are small, average size being about 55 mm. In the Specimen Hill section, however, the specimens are much larger, attaining a diameter of twenty to twenty-five centimeters. The cell apertures are quadrangular at the surface, becoming circular toward the center. Size of the apertures on the outer edge about 2 mm. decreasing to about 1 to 0.5 mm. nearer the center. Hypotype locality: Priest Canyon section, 30' above the base of the formation.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Within the Cañon City embayment the Fremont formation is a compact, dense, fine to coarsely crystalline dolomite that ranges in thickness from zero to 350 feet. The faunal and lithologic characteristics of the formation indicate that it was deposited in a warm, shallow sea in a stable shelf environment.

The marked difference in the fauna and the lithology as compared with the underlying Harding formation indicates an unconformity between the two formations. The overlying formations, the Williams Canyon limestone of questionable Devonian age, and the Pennsylvanian Fountain formation, are in unconformable contact with the Fremont formation.

In the Cañon City embayment, division of the Fremont into the Priest Canyon and massive dolomite members as proposed by Sweet cannot be substantiated either on a lithological or faunal basis.

The Fremont formation contains a large and diverse invertebrate fauna which in most cases is poorly preserved. Five genera of bryozoan, six genera of brachiopods, and six genera of ostracods are reported from the formation for the first time. This fauna contains typical Richmond forms as well as a number of "holdover" forms of Black River and Trenton time. On the basis of the fauna the age of the Fremont formation is considered Richmond in age.

The Fremont formation can be correlated with the English Head, Vauréal and Ellis Bay formations of Anticosti Island, the Stony Mountain formation of southern Manitoba, and the Maquoketa formation of Iowa.

BIBLIOGRAPHY

Barton, Donald C., "A Revision of the Cheirurinae with Notes on their Evolution," Washington University Studies, Series IV, Vol. III, No. 9, 1916.

Bassler, Ray S., "Bibliographic Index of American Ordovician and Silurian Fossils," U. S. National Museum Bull., No. 92, 1915.

Bassler, Ray S., "The Stratigraphy of the Central Basin of Tennessee," Tennessee Department of Education, Bulletin of the Division of Geology, No. 38, 1932.

Bassler, Ray S., "Bryozoa," Part (G) Treatise on Invertebrate Paleontology, Prepared under the guidance of the joint committee on Invertebrate Paleontology: Paleontological Society, Society of Economic Paleontologists and Mineralogists, Palaeontographical Society; R. C. Moore, Editor, (Lawrence, Kansas; Geological Society of America and University of Kansas Press, 1953).

Bassler, Ray S., "Faunal Lists and Descriptions of Paleozoic Corals," Geological Society of America, Memoir 44, 1950.

Bassler, Ray S., "The Early Paleozoic Bryozoa of the Baltic Provinces," U. S. National Museum, Bull. 77, 1911.

Bassler, Ray S., "Bryozoa" (Silurian, Anticosti Island), Can. Geol. Survey, Mem. 154, 1927, p. 263.

Bassler, Ray S., and Kellett, Betty, "Bibliographic Index of Paleozoic Ostracoda," Geol. Soc. of America, Spec. Paper, No. 1, 1934.

Brainerd, A. E., Baldwin, H. L., and Keyte, I. A., "The pre-Pennsylvanian Stratigraphy of the Front Range in Colorado," Bull. Amer. Assoc. Petroleum Geologists, Vol. 17, 1933, pp. 375-396.

Butts, Charles, "The Paleozoic Rocks," Geological Survey of Alabama, "Geology of Alabama," Special Report No. 14, 1926, pp. 41-230.

Cox, Ian, "Revision of the Genus Calapoecia Billings," Nat. Museum of Canada, Bull. No. 80, 1936.

Davis, William J., "A Monograph of the Fossil Corals of the Silurian and Devonian Rocks of Kentucky," In Two Parts, Part II, Kentucky Geological Survey, 1885.

Decker, Charles E., and Merritt, Clifford A., "The Stratigraphy and Physical Characteristics of the Simpson Group," Oklahoma Geological Survey, Bull. 55, 1931.

Flower, Rousseau H., "Cephalopods from the Harding and Manitou Formations of Colorado," Journal of Paleontology, Vol. 26, No. 3, 1952, pp. 508-528.

Flower, Rousseau H., "New Ordovician Cephalopods from Eastern North America," Journal of Paleontology, Vol. 26, No. 1, 1952, pp. 24-59.

Foerste, A. F., "Upper Ordovician Faunas of Ontario and Quebec," Canada Geol. Survey, Mem. 138, 1924, pp. 1-255.

Jones, Owen Thomas, "Plectambonites and some Allied Genera," Memoirs of the Geological Survey of Great Britain, Vol. I, Part 5, 1928, pp. 367-527.

Kirk, Edwin, "Notes on an Early Collection of Paleozoic Fossils from Ellesmereland," Amer. Jour. Sci., Fifth series, Vol. 10, 1925, pp. 445-547.

Kirk, Edwin, "The Harding Formation of Colorado," Amer. Jour. Sci., Fifth series, Vol. 20, 1930, pp. 456-465.

Johnson, J. H., "Resume of the Paleozoic Stratigraphy of Colorado," Colorado School of Mines Quarterly, Vol. 40, 1945, pp. 20-29.

Krumbein, W. C., and Sloss, L. L., "Stratigraphy and Sedimentation," W. H. Freeman and Company, San Francisco, California, 1951.

Lovering, T. S., and Johnson, J. H., "Meaning of Unconformities in the Stratigraphy of Central Colorado," Bull. Amer. Assoc. Petroleum Geologists, Vol. 17, 1933, pp. 353-374.

McFarlan, Arthur C., "The Ordovician Fauna of Kentucky," Kentucky Geological Survey, Series 6, Vol. 36, 1931, pp. 49-165.

Maher, John C., "Pre-Pennsylvanian Rocks along the Front Range of Colorado," U. S. Geol. Survey, Oil and Gas Investigation, Series, Prelim. Chart 39, 1950.

Maher, John C., "Detailed Sections of Pre-Pennsylvanian Rocks along the Front Range of Colorado," U. S. Geol. Survey, Circular 68, 1950.

Milne Edwards, H., and Haime, Jules, "A Monograph of the British Fossil Corals," Printed for the Palaeontographical Society, London, 1850-1854.

Miller, A. K., "The Age and Correlation of the Bighorn Formation of Northwestern United States," Amer. Jour. Sci., Fifth Series, Vol. XX, No. 120, 1930, pp. 195-213.

Miller, A. K., "The Cephalopods of the Bighorn Formation of the Wind River Mountains of Wyoming," Trans. of the Connecticut Acad. of Arts and Sciences, Vol. 31, February, 1932, pp. 193-297.

Loeblich, Alfred R., Jr., "Bryozoa from the Ordovician Bromide Formation, Oklahoma," Journal of Paleontology, Vol. 16, No. 4, 1942, pp. 413-436.

Okulitch, Vladimir J., "Tetradiidae--A Revision of the Genus Tetradium," Trans. Royal Society of Canada, Third series, Vol. XXIX, Sec. IV, May, 1953, pp. 49-72.

Pollack, J. M., "A Faunal Study of the Harding Sandstone in the Cañon City Embayment, Colorado," Unpublished Master of Science Thesis, University of Oklahoma, Norman, Oklahoma, 1951.

Raymond, Percy E., and Barton, Donald C., "A Revision of the American Species of Ceraurus," Bull. Museum Comparative Zoology at Harvard College, Vol. LIV, No. 20 1913.

Rominger, C. "Paleontology. Fossil Corals," Michigan Geological Survey, Vol. 3, Part II, 1873-1876.

Shimer, Hervey W., and Shrock, Robert R., "Index Fossils of North America," New York: John Wiley and Sons, Ltd., 1944.

Schuchert, Charles, "A Synopsis of American Fossil Brachiopods including Bibliography and Synonymy," U. S. Geol. Survey, Bull. 87, 1894.

Schuchert, Charles, and Cooper, G. Arthur, "Brachiopod Genera of the Suborders Orthoidea and Pentameroidea," Mem., Peabody Museum of Natural History, Vol. IV, Part 1, 1932.

Slocom, A. W., "Trilobites from the Maquoketa Beds of Fayette County, Iowa," Iowa Geological Survey, Annual Report, 1914, Vol. XXV.

Ulrich, E. O., Foerste, A. R., Miller, A. K., and Furnish, W. M., "Ozarkian and Canadian Cephalopods, Parts I and II," Geological Society of America, Special Papers 37, 1942; and, 49, 1943.

Ulrich, E. O., "On Sceptropora, A New Genus of Bryozoa with Remarks on Helopora Hall, and other Genera of that type," American Geologist, Vol. I, 1888, p. 288 et seq.

Ulrich, E. O., "Paleozoic Bryozoa," Geological Survey of Illinois, Vol. VIII, part II, sec. VI, pp. 285-688, Vol. VIII, Plates, 1890.

Ulrich, E. O., and Bassler, Ray S., "Paleozoic Ostracoda," Maryland Geological Survey, Systematic Reports, Silurian, 1923, pp. 271-391.

Walcott, C. D., "Preliminary Notes on the Discovery of a Vertebrate Fauna in Silurian (Ordovician) Strata," Bull. Geol. Soc. America, Vol. 3, 1892, pp. 153-172.

Walter, Otto Theodore, "Trilobites of the Maquoketa shale, Iowa," Iowa Geol. Survey, Vol. XXXI, Ann. Rept. 1923-1924, pp. 255-268.

Wang, Y., "Maquoketa Brachiopoda of Iowa," Geological Society of America, Memoir 42, 1949.

Whittington, H. B., and Evitt, W. R., II, "Silicified Middle Ordovician Trilobites," Geological Society of America, Memoir 59, 1953.

Wilson, Charles W., Jr., "Pre-Chattanooga Stratigraphy in Central Tennessee," State of Tennessee Department of Conservation, Division of Geology, Bull. 56, 1949.

Winchell, Newton H., "Geology of Minnesota," Vol. III, Part I, of the Final Report, 1885-1892, pp. 55-474.

Winchell, Newton H., "Geology of Minnesota," Geological and Natural History Survey of Minnesota, Vol. III, Part II, of the Final Report, PALEONTOLOGY, 1892-1896.

PLATE I

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1. <u>Rhombotrypa quadrata</u> (Rominger)...................... 40
   a. Longitudinal section showing portion of mature region, X20.
   b. Longitudinal section showing both mature and immature regions, X20.
   c. Transverse section, X20.

2. <u>Helopora imbricata</u> Ulrich............................ 41
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   b. Longitudinal section, X20.

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   b. Transverse section through large, expanded top of a segment. Note arrangement of zooecia and the presence of the intervening tubes, giving the appearance of mesopores, X20.
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   d. Exterior of the lower half of a segment showing the vertical striations, X20.

4. <u>Hemiphragma</u> sp. indet. 40
   a. Cast of a portion of an external mold.
   b. Section of 4a enlarged to show arrangement of zooecia, X2.5.
   c. Cast of exterior mold of a smaller specimen.

5. <u>Rhinidictya</u> sp. indet. 41
   a. Longitudinal section, X20.
   b. Longitudinal section showing branching, X20.

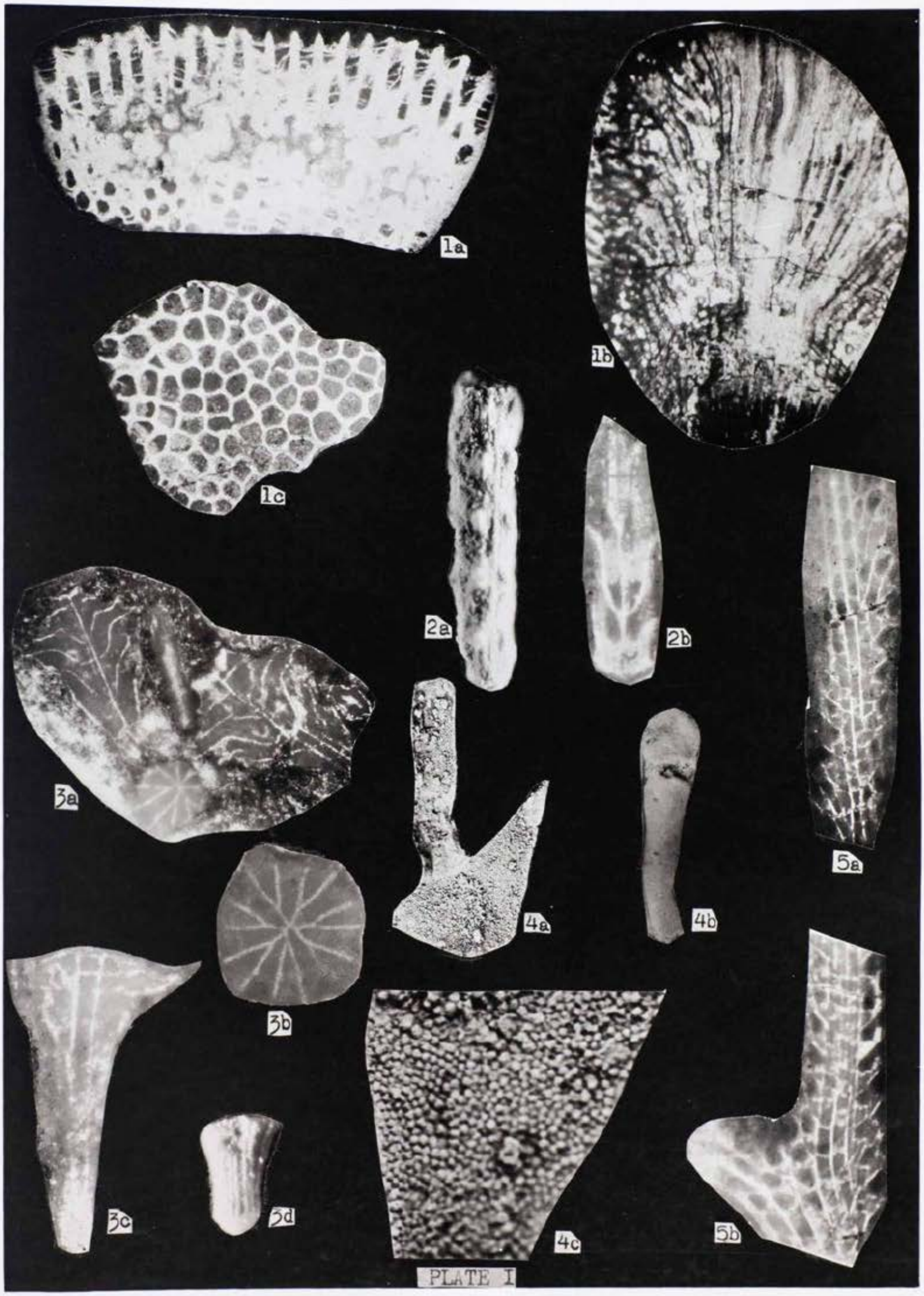

PLATE I

PLATE II

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(All pictures natural size unless otherwise stated.)

1. Plectorthis plicatella (Hall)........................ 43
   a. Cast of a dorsal valve.
   b. Internal mold, ventral valve.

2. Plectorthis fissicosta (Hall)........................ 44
   Ventral valve.

3. Hebertella occidentalis sinuata (Hall).............. 44
   a. Ventral valve.
   b. Posterior view.

4. Platystrophia sp. indet. 45

5. Glyptorthis crispata (Emmons)........................ 46
   a. Ventral valve.
   b. Posterior view showing wide cardinal area.

6. Plaesiomys subquadratus occidentalis (Ladd)......... 47
   Ventral valve.

7. Austinella cf. A. whitfieldi (Winchell)............. 46
   a. Exterior mold of ventral valve.
   b. Cast of the above.

8. Strophomena spp. indet. 51
   a. Mold of dorsal valve interior.
   b. Mold of the exterior, dorsal valve.

9. Lepidocyclus cf. L. rectangularis Wang.............. 48
   a. Top view, dorsal valve, Cast.
   b. Cast of an exterior mold, ventral valve.

10. Rhynchotrema argenturbicum (White).................. 50
   a. Top view, dorsal valve.
   b. Anterior view.
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11. Lepidocyclus sp. indet. 48
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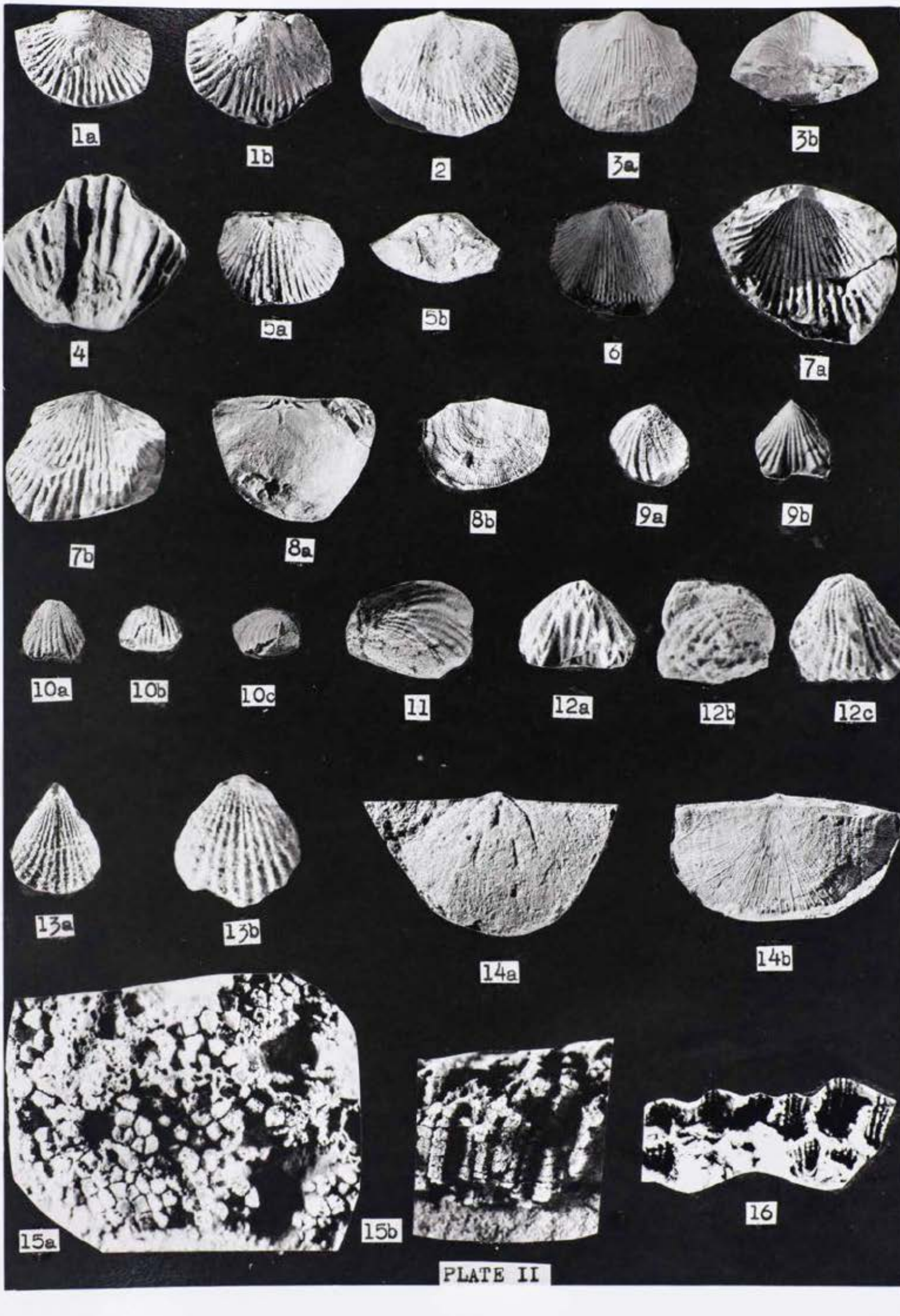
a. Anterior view, X2.
b. Side view, X2.
c. Top view, X2.

13. Zygospira modesta (Say)............................ 51
a. Ventral valve, X2.
b. Dorsal valve of a small specimen, X3.

14. Thaerodonta saxea (Sardeson)....................... 52
a. Mold of the interior, ventral valve.
b. Cast of the dorsal exterior.

15. Saffordophyllum sp. indet. 31
a. Top view of a portion of a large corallum.
b. Side view of the above.

16. Favistella sp. indet. 32
Part of a poorly preserved specimen.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10c
11
12a
12b
12c
13a
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15a
15b
16

PLATE II

PLATE III

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1. *Calapoecia coxi* Bassler.............................. 33
    - a. Top view of a large specimen.
    - b. Top view of an internal mold showing arrangement and position of septa, X2.
    - c. Side view of 1b, X2.
    - d. Top view of a small specimen.

2. *Lichenaria* sp. indet. 30
    - a. Small specimen.
    - b. Larger specimen, note tabulae in corallites on the upper right of the colony.
    - c. Transverse section, X10.

3. *Streptelasma* spp. indet. 35
    - a. Side view of a poorly preserved specimen.
    - b. Side view of an internal mold.
    - c. Bottom view of 3b.

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    - a. Side view of a portion of a large specimen.
    - b. Top view of a polished section.
    - c. Transverse section which illustrates the absence of the intervening tube as in *H. catenularia*, X Nicols, X10.
    - d. Top view of a portion of a large specimen showing "chain" pattern.

5. *Palaeophyllum thomi* (Hall)........................ 32
    - a. Polished section, retouched to show arrangement of coralla.
    - b. Transverse section showing arrangement of septa, X3.
    - c. Longitudinal section, X3.

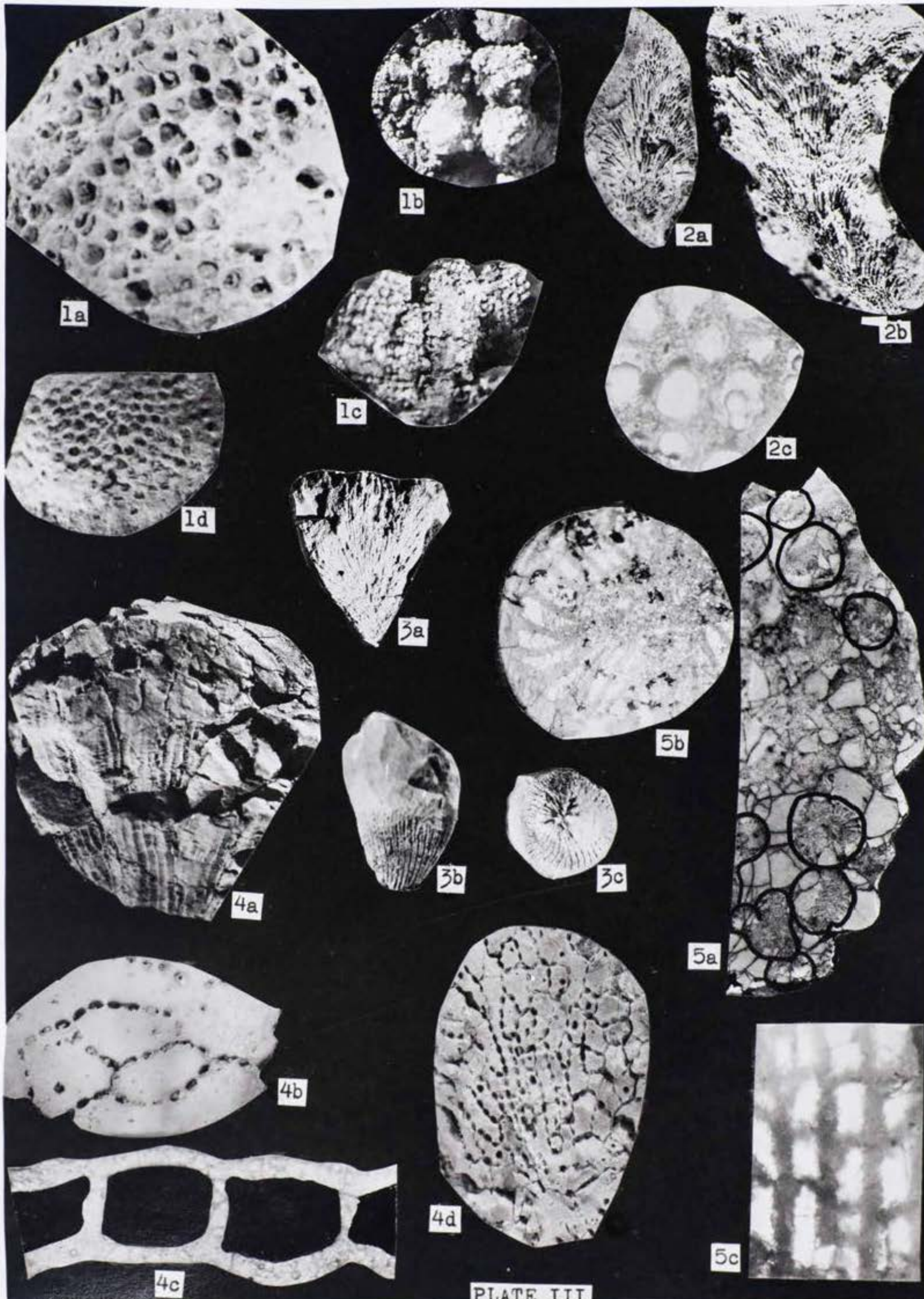

PLATE III

PLATE IV

11. Paraparchites subovatus, n. sp. 61
a. Right valve, X30.
b. Left valve, X30.

12. Hallatia healyensis Kay........................... 63
a. Right valve, X24.
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13. Leperditella aequilatera (Ulrich).................. 62
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b. Small specimen, X24.

14. Leperditella sulcata (Ulrich)...................... 62
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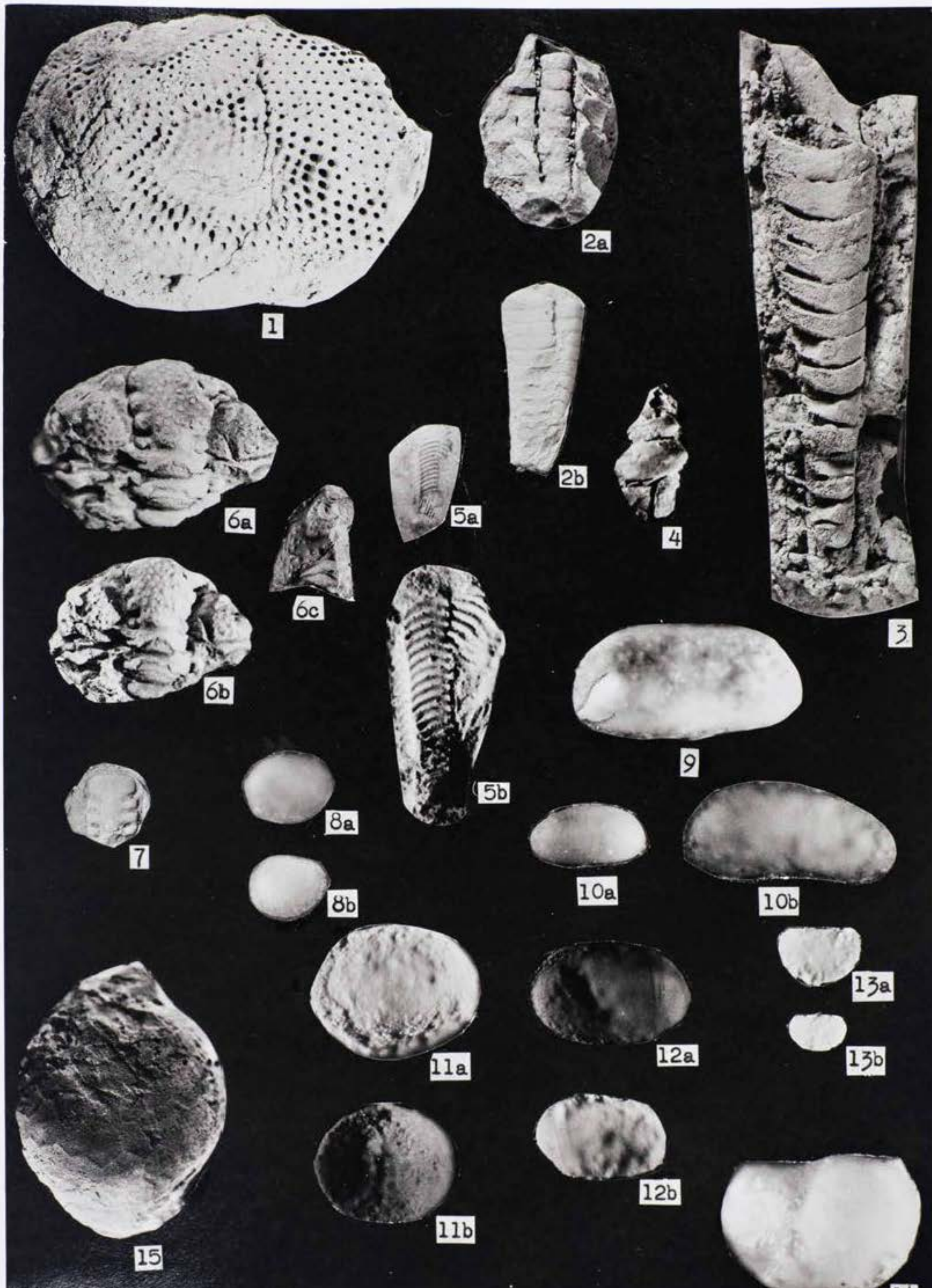
15. Archaeocrinus sp. indet. 37
Lateral view.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11b
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PLATE IV

MEASURED SECTIONS

SECTION I

South Hardscrabble Creek, Custer County.

This section of Fremont stands nearly vertical as a result of faulting. Section measured on top of hill on north side of State Highway 274, ½ mile west of intersection with State Highway 23.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, red to purple, fine to medium crystalline, abundant crinoid stems, with some calcite veins...............................	28

SECTION II

Specimen Hill, Fremont County.

SE¼ sec. 32, T. 19 S., R. 70 W.: Measured by steel tape on west side of Oak Creek grade road, 2.7 miles SW of the old town of Chandler. Beds strike N. 14 W. and dip 77 degrees E.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, buff, finely crystalline, many silicified fossils, especially brachiopods.....	31
Dolomite, tan, finely crystalline, highly fossiliferous; blue-white opaline chert bed a few inches to almost a foot thick........	40
Dolomite, buff to tan, medium crystalline; abundant <u>Receptaculites oweni</u> Hall.............	10
Dolomite, red to pink, medium to coarse crystalline, Contact with Harding formation irregular.......	11
	92

SECTION III

Priest Canyon

Sec. 13, T. 18 S., R. 71 W.: Measured along the Priest Canyon road three miles northwest of Cañon City.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, thin-bedded to massive; tan to buff purple mottled; fossiliferous.............	57
Dolomitic shale, platy.................................	5
Dolomite, fine to medium crystalline, tan to buff, with some pinkish beds; fossiliferous....	100
Dolomite, light tan; pink, fossiliferous; fine crystalline; some calcite filled vugs...........	100
Dolomite, pink to purple; coarsely crystalline; highly altered at base; fossiliferous..........	17
	279

SECTION IV

South Twin Mountain, Fremont County.

S½ sec. 1, T. 18 S., R. 71 W.: Measured ¼ mile west of the Colonna Brothers quarry. Dip 30 degrees E., strike N. 9 W.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, finely crystalline, tan to buff with purple mottling, manganese dendrites common, fossiliferous, massively bedded................	42
Dolomitic shale, hard, laminated, pink to purple in color, weathers blocky. Silicified zone occurs at base of this shale bed...............	8
Dolomite, tan to buff and pink in some beds, fine to medium crystalline, massively bedded; fossiliferous.......................................	200
Dolomite, hard, dense, finely crystalline except near base where there is 10 feet of coarsely crystalline dolomite; fossiliferous with a prominent zone of <u>Leperditella</u> sp. about 10 feet above the base; blue-white chert along bedding plane 38 feet above the base. Contact with underlying Harding very irregular.........	100
	350

SECTION V

Paradise Ridge.

Sec. 35, T. 17 S., R. 71 W.: Section measured on hogback, ½ mile west of Wilson Creek road, 5.7 miles from United States highway 50; strike N. 15 W., dip 27 degrees northeast.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, hard, dense, finely crystalline, tan to buff; upper beds platy and contain many corals	93.6
Dolomite, tan to buff, finely crystalline; exceedingly porous due to abundant corals	72.8
Dolomite, tan to buff, fine to medium crystalline	46.8
Dolomite, tan to buff, finely crystalline, corals and Receptaculites oweni Hall	36.4
Dolomite, hard, dense, tan to buff, traces of calcite in weathered zones	41.6
Dolomite, tan to buff, finely crystalline	15.0
Dolomite, red to pink, altered near base. Contact with Harding irregular	15.0
	321.2

SECTION VI

North Kansas Camp.

Section measured ½ mile north of University of Kansas Field Camp. Fremont formation horizontal. Upper part of the Fremont formation has been eroded.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, red to buff with manganese dendrites; finely crystalline; non-fossiliferous	30
Dolomite, hard dense, with stringers of intraformational conglomerate; non-fossiliferous	32
Dolomite, red to tan; fine to medium crystalline; non-fossiliferous	34
	96

SECTION VII

Gately Hogback

Sec. 9, T. 18 S., R. 69 W.: Measured ½ mile NW of Gately Ranch at entrance to Phantom Canyon. Strike N. 60 W., Dip 10 degrees W.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, hard, dense, buff to pink and finely crystalline; non-fossiliferous......	4

SECTION VIII

Fremont Saddle.

Sec. 4, T. 18 S., R. 69 W.: Measured in saddle of hogback between Stevenson's Creek and 8 mile Creek and ½ mile SE of junction of Idaho Springs Creek and 8 mile Creek. Strike E-W, dip S.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, buff to maroon, finely crystalline, fossiliferous..................................	12

SECTION IX

North Lion Creek.

Section measured ½ mile north of first bridge crossing Beaver Creek, sec. 32, T. 17 S., R. 68 W. Strike N. 15 E., dip 35 degrees SE.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, fine to medium crystalline, tan to buff, few fossils..............................	38
Dolomite, tan to buff, fine to coarsely crystalline, sandy with yellow sand lenses locally in lower part; fossiliferous, brachiopods common........	12
	50

SECTION X

Beaver Creek.

Sec. 33, T. 17 S., R. 68 W.: Strike N 15 E., dip 34 degrees SE. Measured ½ mile north of the gate at end of county road.

Lithologic Description	Thickness In Feet
Fremont formation	
Dolomite, tan to buff, fine to medium crystalline, few fossils..............................	35
Dolomite, tan to buff to pink, manganese dendrites; sandy, with some local sand lenses; brachiopods fairly abundant..........................	13
	48